EIGHTEENTH YEAR OF PUBLICATION.

THE JOURNAL OF SCIENCE,

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

(MONTHLY, FORMERLY "THE QUARTERLY JOURNAL OF SCIENCE.')

Vol. III. (THIRD SERIES)
No. XCI.

JULY
1881.

CONTENTS.

ARTICLES. PAGE

1. The Source of Electric Energy. By CHARLES MORRIS 377
2. A Handful of "Nuces Zoologicæ," and their Cracking. By J. W. SLATER.. 391
3. An Estimate of Auguste Comte. By G. H. C.. 398
4. Physiology of Mind-Reading. By GEORGE M. BEARD, M.D. 407

ANALYSES OF BOOKS.

Illusions: a Psychological Study 426
Electric Meteorology 423
The Glacial Beds of the Clyde and Forth 423

ANALYSES OF BOOKS—*continued.* PAGE

Essay on the Artificial Propagation of Anadromous Fish other than the Salmon, and the Restocking the Tidal Waters of our Large Rivers artificially with Smelts 424
Prize Essay, National Fisheries Exhibition, Norwich, 1881 .. 424
The Progress of Science 425
Observations on Mount Etna .. 426
Report on Insects Injurious to Sugar-Cane 426

CORRESPONDENCE 427

NOTES 433

LONDON:

3, HORSE-SHOE COURT, LUDGATE HILL.

Where Communications for the Editor and Books for Review may be addressed.

PRICE ONE SHILLING AND SIXPENCE.

NEW WORK BY PROFESSOR GALLOWAY.

Just Published, price 10*s.* 6*d.*

EDUCATION, SCIENTIFIC AND TECHNICAL;
or,
HOW THE INDUCTIVE SCIENCES ARE TAUGHT; and HOW THEY OUGHT TO BE TAUGHT.

London: TRÜBNER and CO., LUDGATE HILL.

On July 1*st, Part I.,* 2*s.* 6*d.*

THE MICROGRAPHIC DICTIONARY:

A GUIDE TO THE EXAMINATION AND INVESTIGATION OF THE STRUCTURE AND NATURE OF MICROSCOPIC OBJECTS.

By J. W. GRIFFITH, M.D., &c.,
AND
ARTHUR HENFREY, F.R.S., &c., Professor of Botany in King's College, London.

FOURTH EDITION, Illustrated by 53 Plates and more than 800 Woodcuts, Edited by Dr. GRIFFITHS, assisted by the Revd. M. J. BERKELEY and Prof. T. RUPERT JONES.
To be Completel in about 21 Monthly Parts.

JOHN VAN VOORST, 1, PATERNOSTER ROW.

South London School of Pharmacy,
325, KENNINGTON ROAD.

MANAGING DIRECTOR—DR. MUTER

Daily Lectures on the following subjects:—

Chemistry.	*Physics.*	*Pharmacy.*
Botany.	*Materia Medica.*	*Classics.*

THE CHEMICAL NEWS

Edited by WILLIAM CROOKES, F.R.S., &c.

Published Weekly, price 4*d. Annual Subscription,* £1, *payable in advance.*

This Journal is devoted to Scientific and Applied Chemistry, and also embraces whatever tends to elucidate new discoveries in Mineralogy, Metallurgy, Mining, Mechanics, Electricity, and the collateral branches of Physical Science. It also contains an encyclopædic list of chemical papers published abroad during the previous week, with abstracts of all susceptible of advantageous abridgment, thus making the two half-yearly volumes, with their copious indices, equivalent to an English edition of the "Jahresberichte."

LONDON: BOY COURT, LUDGATE HILL, E.C.

CAL ;

ow

:

ON OF
CTS.

r

oodcuts,
Prof. T.

acy,

y.

W S

advance.

whatever
Electricity,
dic list of
usceptible
ir copious

XUM

THE

JOURNAL OF SCIENCE.

JULY, 1881.

THE SOURCE OF ELECTRIC ENERGY.

By CHARLES MORRIS.

THE molecules of matter are affected in two distinct modes by centrifugal motion. In the one case this motion is, to a considerable extent, persistent in the affected molecule. Its excess vigour is but slowly yielded to other molecules, through the influence of impact or of attractive connection. This mode of motion is called heat. In the other case the molecules vigorously transmit their excess motion, yielding it with excessive rapidity to other molecules. To this phase of motion we give two names. In one form of its manifestation we designate it as radiant energy. In another form we give it the name of electricity. Whether or not, however, we should speak of these as one mode of motion, or as two distinct modes, is a question which yet remains unanswered, and is, to a partial extent, the question which it is proposed to consider in this paper.

Between heat and radiant energy there are intimate relations. They interchange with the utmost readiness under proper conditions. The same may be said in respect to heat and electricity. They, also, have close affinities, and interchange with facility. Any enquiry, then, into the relations between these three modes of motion involves an answer to the following question—Why, under one set of conditions, does the molecule of matter vigorously retain its motion; and why, under another set, or two other sets, of conditions, does it vigorously transfer its motion? And what are the characteristics of these two or three distinct sets of conditions?

In regard to heat and to radiant energy, science gives definite answers to these questions. Heat it declares to be a persistent motion of molecules, either independent of special control, as in the gas, or controlled by attraction, as in the solid and liquid. Radiance it declares to be a rapidly transmitted vibration of molecules or of etherial particles, through whose agency motive energy is directly transferred across wide intervals of space. This explanation, however, is questioned; and the latest theory, that of Clerk Maxwell, declares that there is no direct transfer of energy, but that it is, in some manner, indirectly transferred. In regard to electricity, the question yet remains unanswered. Is it a directly or an indirectly transmitted energy? Is it a rapidly transferred vibration, as in the first explanation of radiant energy? Or is it a result of some distinct and peculiar mode of motion? These are questions which still lack a solution.

As to the conditions under which radiant energy is transformed into heat, we are not without a satisfactory conception. When a beam of light or radiant heat, consisting of vibrations of greatly varied rapidity, falls upon the surface of a body, a certain portion of this energy is retained by the body, and the remainder either transmitted or reflected. The retained energy becomes heat, and little doubt is entertained as to the principle of its conversion into heat. The particles of the body acted on are at a certain tension, dependent upon their weight, their attractive connections, and the pressure to which they are subjected. Their heat vibrations, therefore, take place at a certain fixed pitch, on the same principle that a stretched string vibrates at a pitch in strict accordance with its tension. When the rays of light impinge upon these molecules every vibration which is in harmony with the pitch of molecular vibration is retained, and becomes heat. Every vibration in discord with that of the molecules is rejected. The principle is precisely the same as that of a string stretched to sound a certain note, near which a second string is made to vibrate. If the note of the second string accords with that of the first, this latter will take up the vibration. If it be discordant, the first string will remain unaffected.

If, now, we come to consider the conditions under which heat becomes electricity, we find indications of a similarity to those just considered. Every substance has its normal pitch of molecular vibration, which differs, however, with every difference in the tension of the molecules. If two homogeneous surfaces be brought into contact heat is regularly conducted from one to the other. And if a substance

be homogeneous throughout its interior, heat is regularly conducted through it. But if the two surfaces be heterogeneous, or if the one substance be heterogeneous internally, a marked difference results. Part of the heat is converted into electricity. Instead of the energy passing from molecule to molecule in the gradual and continuous heat method, part of it passes in the rapid and instantaneous electric method.

Very slight changes yield this result, and these changes are probably all changes in tension. If a wire be twisted or stretched, the heat that flows over this tense part becomes partly converted into electricity. Of if it be homogeneous, and one part of it be intensely heated, electricity likewise appears. Yet in this latter case there is also a change in tension, for the heat causes expansion of the wire, and consequently increased atmospheric pressure, which must affect the tension of the molecules. In the contact of diverse substances, or of similar substances in different states, there undoubtedly exist differences of molecular tension, and, therefore, of vibratory pitch.

If, instead of heat being conducted from one substance to another, two substances be rubbed together, similar results appear. If they are homogeneous it partly or entirely becomes electricity. And if the energy emitted be that produced by chemical action between diverse substances, a like result appears. Electricity is produced. In short, in every case in which two homogeneous surfaces receive excess motive energy, this energy flows from one to the other as heat. In every case where two heterogeneous surfaces receive excess motive energy, this energy, partly or completely, flows from one to the other as electricity. But all this electricity is eventually converted into heat, or into some condition in correlation with heat. Its existence as electricity is usually but temporary.

And the necessary condition for the temporary conversion of heat energy, or of chemical or mechanical energy, into electricity, appears to be diversity of tension in the molecules of contiguous surfaces. The same diversity exists between the molecules of heated solids and those of the gas or ether in contact with them. There is thus an analogy of condition between the production of light and of electricity. Whether this is significant of a resemblance in character remains to be proved.

Why does this difference in the relations of the two surfaces produce such a difference in results? To this important question it may be possible to give a probable

answer. In homogeneous bodies the tension of the molecules is similar, and their heat vibrations are, therefore, synchronous. The particles swing in exact unison between the attractions to which their vibration is due. They do not come into contact with each other, nor do they in any way disturb each other's condition of aggregation. They yield motive energy to one another only by the slow pull of attractive force. In homogeneous gases, however, the attraction is not sufficient to produce vibration. The molecules, therefore, move independently, and come into incessant contact. But, for reasons to be yet given, they do not disturb each other's condition of aggregation. The chief result of their impact upon each other is the equalisation of motive energy.

In heterogeneous bodies this synchronism of vibration does not exist. There is a certain degree of discordance between the motions of adjacent molecules. As a consequence they come into contact with each other. But there is another consequence of heterogeneity which is far more important; a disturbance of the conditions of motion and of aggregation, which the molecules of each surface produce in those of the other. This disturbance we know by the name of electric induction. It is the most significant feature of electric action, and possibly contains among its phenomena the solution of the mystery of electric transmission. Before considering it, however, there are other essential features of the transfer of energy to be taken into account. Among these are some special points of analogy between the phenomena of light and radiant heat and those of electricity.

If we examine closely the action of radiant vibrations on solid and liquid substances, we find other effects than those already mentioned of partial absorption and conversion into heat. There are special resistances, which differ in degree in different substances. The energy of motion concerned in radiant vibrations cannot cease to exist. It must force itself upon molecules as heat vibration, force itself through masses as radiant energy, return through the air as radiant energy, or be converted into some other mode of motion, such as chemism or mass motion. And to every one of these changes in condition there is a resistance, the result being in exact accordance with the balance of resistances. If there be sufficient accord between the radiant vibration and the molecular heat vibration, the radiant energy will be absorbed as heat. If they be discordant there is a vigorous resistance to absorption, and the energy continues radiant. Two other ordinary resistances remain, the one a resistance to trans-

mission of radiance through the substance concerned, the other a resistance to a return of the ray through the air. If the former resistance be the least the ray will be transmitted, and we call the substance a transparent. If the latter be the least the ray will be reflected, and we call the substance an opaque.

But this power of resistance has its peculiarities. Some substances resist all radiant vibrations, and are completely opaque. Others resist one range and are permeable to another. Some, for instance, permit the light rays to pass, and are opaque to the lower heat rays. Others, as rock salt, are highly transparent to these lower heat rays. Some again, among the opaques, are permeable to a slight degree, as gold for instance. Thus, whether a radiant beam, or any portion of it, shall be repelled through the air, or shall pass through the body upon whose surface it falls, depends upon the relative degree of resistance to transmission or reflection. Perhaps where resistance to both transmission and reflection is great the resistance to absorption may be more fully overcome, and vibrations only slightly in accord with the heat vibrations be received as heat. It seems, indeed, as if it might be but a question of relative resistances, these resistances being of three or more separate kinds, and the motive energy being divided up among them according to the special vigour of each resistance to each component of the ray.

These considerations in regard to light are not without their bearing upon the question of electric energy. For although many substances are completely opaque to the whole range of etherial vibrations, it does not follow that they must be opaque to all possible vibrations. The vibrations which constitute light and radiant heat occupy but a limited portion of the whole range of possible vibratory pitch. Between the lowest heat ray and the highest vibration of sound there is a vast void, capable of containing vibrations immensely varying in pitch. The whole range between several thousands and several millions of millions of vibrations per second is apparently unoccupied, and into this wide space it would not be safe to conclude that no phenomena of motion can enter. It may, indeed, be possible that every substance is transparent to vibratory waves of a certain limited range of pitch, and opaque to all above and below this range. The range of vibrations to which ether is transparent is really limited, so far as indications go. Of course, it is possible that the light and heat

rays we receive are transmitted by the air, not by the ether; and that, therefore, we know only the range of atmospheric transparency. There may be etherial rays which are reflected at the surface of our atmosphere, and which fail to penetrate to us. As for solid and liquid substances, some are transparent to this whole range, some to a portion of it only, and some opaque to the whole. But these latter may be transparent to some other range of vibrations, possibly of lower pitch than those of light and radiant heat. The highly opaque metals, for instance, may be transparent to a range of vibrations to which air and the other transparents to light are completely opaque. And it is not impossible that such a range of vibrations constitutes electric energy, for it is a well known fact that all good electric conductors are highly opaque to etherial radiation, and that the most of transparent solids are good insolators of electricity. Some transparent liquids, however, conduct electricity imperfectly; but this would only show a wide range of transparency in these liquids.

There is another fact, of some importance in this connection, which it will be well to mention before proceeding. This is the fact that all the best transparents to light are colourless. There are but few transparents which possess colour, and the transparency of these is imperfect. Opaque substances, on the contrary, are usually of strongly declared colour. Some of them reflect all the light rays, and are white in hue. Others absorb a portion of the rays, and are of some special shade of colour. Others, again, absorb all the rays, and are black. Are there not some peculiar relations revealed in this diversity of behaviour to light? Two sets of substances resist absorption of light, the colourless and the white. Of these the first set is transparent. It conducts light. The other set is opaque. It resists light in every sense, and repels it through the air. Of coloured substances some absorb more, some less, of the light rays; some reflect the unabsorbed portion, others partly transmit it. And, finally, the transmission of light through the best transparents is only partial. In all of them it is partly converted into heat.

These facts are singularly paralleled by certain facts in electrical behaviour. To electricity, as to light, certain substances are transparent, others opaque. But the best transparents, or conductors, absorb a portion of the electric current and convert it into heat. Poor conductors absorb a considerable portion of the current. They resemble the coloured transparents to light, or translucent substances.

Non-conductors resemble opaques to light. Some of them absorb a portion of the electric energy, others refuse it altogether. They are white to the electric ray. The opaque absorbents of electricity, however, have their direct analogy in phosphorescent substances. For the electricity which penetrates them does not become heat, but is subsequently emitted as electricity; precisely as the light which penetrates phosphorescents does not become heat, but is subsequently emitted as light.

Electricity and light hold to each other the following relations:—Transparents to light are, as a rule, opaque to electricity. Transparents to electricity are opaque to light. Electric rays within a solid can no more escape from it into the opaque air than light rays can escape from the air into an opaque solid. The electric rays may seem to differ from the light rays in that the former can be retained for a long time within a limited space, while light rays, when repelled, instantly disappear. But so do electric rays when they have the same opportunity. Light has an unlimited expanse of transparent matter into which to disperse. Electricity would disperse with equal rapidity and completeness within an unlimited sphere of metal, for its rapidity of transmission is closely similar to that of light. The marked differences which we discover between these two modes of energy may entirely arise from the differences of condition under which we observe them.

We may conceive of light under circumstances similar to those under which we usually observe electricity. For if we imagine a beam of light to enter a space surrounded by opaque surfaces, and closed so that the light cannot escape, we would have a case closely resembling that of a charged conductor surrounded by an insulating medium. Just how light would behave under such circumstances it is not easy to decide. We know, as will be shown further on, that it could not dart continually from side to side of the space. It might exist as a surface energy like electricity. It might slowly force itself into the surrounding surfaces, as electricity will force itself into insulating glass. Only this we can positively declare, that if a slight opening to the outer air were made any active light rays would instantly dart through this transparent channel and escape from their confinement. But we also know that, in the case of a charged electric conductor, if a slight opening be made through the opaque air, by bringing the extremity of a wire into contact with the conductor, the electric rays will instantly dart out by this conducting channel, and rush over the wire with the speed

of light. And if the wire be led to earth, the electricity will disperse as completely as the light would in the former case.

There are electrical phenomena which we cannot discover in light, and light phenomena which we cannot discover in electricity. But they each exist under conditions in which it is impossible to place the other. In short, as under the form of light we are enabled to discover many of the phenomena of radiant energy and of its relations to substance, so under the form of electricity we are enabled to discover others of these phenomena. To gain a full conception of radiant energy, the phenomena of etherial radiance and electricity must be considered in common, and dealt with as the various phases of one general mode of motion.

The most marked of these peculiar electrical phenomena are those of induction. Whether or not light rays have any analogous characters it is impossible to decide experimentally, since light cannot be placed under the conditions necessary to induction. We cannot charge a transparent with light, and examine its behaviour under such conditions, as we can charge a conductor with electricity and examine its behaviour. In the investigation of radiant phenomena, then, electricity affords us peculiar facilities in one portion of the field, as light and radiant heat affords us peculiar facilities in another portion of the field.

And in connection with electric induction, there is another special feature of electric energy which is full of significance. This is the fact of its existence in two opposite and mutually repressive states, its positive and negative conditions. By induction, we simply mean a separation of the energy of molecules into these two electric states. It is produced under the influence of electric energy in some conductor, and consists in a disturbance of the molecular energies in neighbouring matter, and a separation of these energies into two opposite states, known as the positive and negative electric states. And this separation is accompanied by what seems a repulsion of the electric state resembling that in the charged conductor, and an attraction of the opposite state of electric energy. This influence extends in all directions, internally as well as externally. To it is due the confinement of electricity to the surface of the conductor, as will be shown further on.

The influence of inductive energy appears to be almost or quite as universal as that of gravity. It extends indefinitely outward from the electrically excited body, and affects all materials, of whatever character, though not with equal

energy. There is, in fact, a resistance to inductive action, which varies in different substances; and it is, therefore, probable that the most vigorous inductive influence must soon be rendered null in a di-electric medium, though it seems capable of producing effects at very great distances in conducting material.

Inductive action seems to be, in its primary character, a strictly molecular influence, its tendency being to disturb the motive conditions of molecules. If the substance affected be a non-conductor of electricity, this is the limit of the inductive effect. But if it be a conductor, this first effect is followed by a second, the electric disturbance ceases to be confined to the molecules as individuals, and affects the mass as a whole. When, for instance, a charged conductor is surrounded by an insulating medium, its inductive effect upon this medium is certainly not of the mass as a whole, and therefore must be of the molecules as individuals. Its character is, probably, a disturbance of motive conditions, and its result is the appearance of positive electricity at one end, pole, or atom of the molecule, and of negative at the other. In the case of a conductor we have but to substitute the word mass for molecule, and the same description applies.

The mode of inductive action may be a separation of the normal or heat movement of the molecule into two dissimilar components, one above and one below the normal vibratory pitch, which respectively occupy or affect the poles of the molecule, or the two atoms, or two sets of atoms, of which it is made up. If we view the molecule as composed of two atoms, or two molecular constituents, one of these may be forced to vibrate at a rate above that normal to the molecule, and the other at a rate below the normal, they being thus respectively in positive and negative electric states. Such a discordance in motive relations set up between the atomic components of a molecule would presumably tend to weaken their cohesion, and to render the molecule susceptible to chemical change. In the case of electrolytic phenomena, we have such a susceptibility as a strongly declared feature of inductive action.

Before pursuing this line of thought further, however, it may be well to briefly consider certain probable conditions of molecular organisation. We may, in fact, look upon a molecule as a minute mass composed of atoms, in the same manner as a mass is composed of molecules. And very probably the same motive relations exist between the molecule and its atomic components as between the mass and its

molecular components. In the latter case there is a frequent interchange. Now the motion of the mass as a whole ceases, and is taken up by its molecules, to become heat vibration. Now the heat vibrations respond simultaneously to some exterior force, and thus become partly converted into mass motion. In like manner the motion of the molecule as a whole may be hindered by some exterior force, and become a motion of its atomic components. And, again, the motions of these components may be made to act in concert through some exterior force, and thus yield molecular motion. The forces producing these changes are the same in both cases. They are either impact or are attraction and repulsion exerted by distant masses. And the conditions may be the same. A pendulum vibrating at its normal pitch, if affected by a motive influence discordant to this vibration, could not respond to it as a mass. The effect, therefore, must be produced upon its molecules, which would gain new motive energy. In like manner, a molecule, affected by molecular motive influences in discord with its pitch of vibration, might refuse to respond, the atoms responding instead, with the production of what we may term an intra-molecular heat. If these molecular influences are attractive, they resemble the action of gravity on masses; if they are energies of impact, they resemble the action of collision between masses in motion.

Electrical induction is such a molecular influence, proceeding from molecules whose rate of vibration is discordant to that of the molecules upon which they act. The consequence seems to be a production of atomic energy. This energy does not necessarily come from the acting molecules, but may be a partial transformation of the vibratory energy of the affected molecules. Their freedom of movement may be curtailed by exterior resistance, and part of their motive energy fall back into their substance and become atomic energy. It is a case similar to that in which a body is thrown upward against gravity, when its rapidly diminishing mass motion falls back into its substance, and becomes a rapidly increasing molecular vibration. Or it resembles the case of a pendulum which comes to rest at one extremity of its swing, its motion as a mass having become converted into motion of its molecules as independent particles, to be re-converted into mass motion in its return swing. It is very probable that changing conditions of motion similar to this last are of constant occurrence in molecular action; and in the case of electrical influence, there may be a force exerted upon the molecule restrictive of its mass motion, which thus

becomes partly converted into atom motion or intra-molecular heat force.

It becomes advisable here to more fully consider the relations between the molecules of heterogeneous surfaces. Their influence upon each other is, very probably, a strong effort to produce homogeneity. Two molecules vibrating in contact, or in close contiguity, seek to force each other into accordant vibratory conditions. Each affects the tension of the other by changing each other's attractive relations. Yet in each there is a resistance to this effort to produce conformity, and this resistance is strengthened by the action of the more distant molecules of its own kind. There is thus a marked distinction between the action of homogeneous and of heterogeneous surfaces upon each other. In homogeneous surfaces the molecules all vibrate in strict accordance, and the only effect of the passage of motive energy from one to the other is an increased width of vibration, constituting heat conduction. In heterogeneous surfaces, the molecules of the two surfaces vibrate discordantly. Each seeks to force the other into harmony with itself, and each resists this effort. There results a disturbance of motive conditions in each, the degree of disturbance being controlled by the degree of resistance. This disturbance, however, does not seem to be a forcing of each molecule as a whole to vibrate at a new rate, but it appears to be a separation of the normal vibration into two components, one at a higher and the other at a lower vibratory pitch than the normal, and a localisation of these separate vibrations upon the two poles of the molecule. And, further, the low pitch vibration of one molecule occupies the pole contiguous to that occupied by the high pitch vibration of the other. Such we conceive to be the essential character of the force disturbance known as electric induction. Each disturbed molecule similarly affects all contiguous molecules of its own kind, so that the inductive effect runs back indefinitely through both substances.

In a non-conducting substance this is the extent to which inductive action proceeds. The disturbance is molecular only, and does not extend to the mass. But in conducting bodies the action is exerted upon the mass. Molecular energy is first disturbed, and the poles of the molecules become respectively positive and negative. But this is followed by electric conduction from molecule to molecule, which consists in a neutralisation of the electric disturbance on the adjacent poles of each two contiguous molecules. These possibly vibrate together, and their opposite electric

energies combine, and produce the intermediate heat vibration. Thus the only unsatisfied electric disturbance is that of the outward poles of the surface molecules. And this electric vibration probably flows back over these molecules, which thus become the electrified poles of the mass. A conductor thus differs from a non-conductor in the fact that in the latter case the molecules are independently electrified, in the former the whole mass acts as a single electrified molecule, the electricity being confined to its surface, and it being neutral internally.

Physical science is, in a much larger sense than is usually supposed, a science of molecules, and scientists have made many serious errors through confining their attention to masses and being oblivious to the fact that every action displayed by masses simply results from a partial restriction of the directions of molecular movements. Molecules are, very largely, independent of any common control. So far as electrisation goes, the molecules of non-conductors are thus independent, each acting as a separate mass. But in conductors they mutually restrain each other, and the electrisation becomes confined to the exterior molecules, which cannot discharge their force inwardly on account of this mutual restraint, nor outwardly on account of the resistance to conduction in the surrounding medium.

If, now, it be asked what is the underlying cause of the peculiar characteristics of induction, we cannot hope to give more than a conjectural answer. Why, for instance, does positive electric force repel positive induced force and attract negative, so that there is a distinct separation and special arrangement of these energies in the induced body? In fact, however, but three results could possibly arise from the approach of an electrified to a neutral body. In the first conceivable case, the body must remain unaffected, its molecular forces being undisturbed. In the second, the electrified body might attract similar electricity, or produce a like electric polarisation to its own on the adjacent surface of the second body. This result would affect all the molecules, two adjacent negative and two adjacent positive poles succeeding each other alternately, for the molecules must act upon each other on the same principle as masses affect each other. Such a state of affairs would absolutely hinder any conduction of electricity. There could be no electric neutralisation from molecule to molecule, while there would be a tendency to neutralisation of the opposite energies in the same molecule; and thus conduction, and perhaps production, would be forcibly prevented.

A third possible relation of the electric energies remains, that really existing. And its existence may be a result of a vigorous reactive influence in the motive force of matter. If there be a tendency to reversal of disturbed conditions, which amounts to an active energy, then we can conceive of the possibility of a forcible production of conditions like those which really arise. A molecule has a normal condition of motive energy. This is disturbed or divided into two separate conditions, to which we give the names of positive and negative electricity. But this disturbance takes place in opposition to a resisting energy, or a strong tendency in the molecule to retain or to resume its normal condition. The positive and negative energies on the poles of the same molecule tend to flow together and re-combine into the normal energy. But they also exert a like force exteriorly. Thus the positive seeks to satisfy itself from the possible negative of the adjacent molecule, and in doing so it exerts a disturbing force on the energies of this second molecule, causing a similar division of its normal motion into two components, of which the negative component occupies the adjoining pole, while the positive component is similarly related to the negative of a third molecule. So the negative pole of the first molecule exerts a similar decomposing effect upon the energies of adjacent molecules. The constant tendency is to neutralisation of these disturbed conditions, and this result may take place either inwardly or outwardly. If neutralisation takes place inwardly the molecules simply resume their normal condition, and no evident change occurs. If it takes place outwardly, between the oppositely charged contiguous poles of adjacent molecules, a positive transfer of motive force results, and it is this transfer of force which we know as electric conduction.

Inductive action acts inwardly upon the interior molecules of the charged conductor as well as outwardly upon surrounding matter. Each molecule, in fact, acts as an independent body, and affects those with which it is immediately as well as those with which it is remotely connected. Thus in the charged conductor every molecule acts inductively upon all the remaining molecules. There is, consequently, an equal inductive effect in opposite directions upon all the interior molecules. The disturbance of their energies produced by the charge in one direction must be balanced by an equal disturbance produced by the charge in the opposite direction. From this balance of opposite energies neutrality must arise.

Thus the interior of the charged conductor is electrically

neutral, and all the charge is confined to the surface. The portion of the charge on any one surface by its inductive action tends to disturb the energies of all interior molecules, and to produce an induced charge upon the opposite surface. But the portion of the charge on this surface exerts an equal influence in the opposite direction. Thus the internal molecules, not being able to respond simultaneously to two exactly opposite and equal influences, remain unaffected, and all the electric charge is confined to the surface. The force which confines it there is not really a mutual repulsion of the surface charge, but practically it produces the effect of such a repulsion.

The case of the approach of two similarly charged conductors is essentially the same as the above. If brought into contact they act precisely like a single body, opposed inductive energies affect the molecules in contact, and their charge is transferred to the remaining surfaces. But, as there is in this case a decrease in the extent of available surface, the vigour of charge on each portion of the surface is increased. Possibly the abnormal vibrations swing through a wider space in consequence of this crowding of their energy into a more contracted region. If the charged conductors be slightly separated, the effect is simply to introduce an element of resistance into the problem. The inductive effects on the adjacent surface of each of the bodies differ in degree, since in the one direction it is induction through the conductor only, in the other it acts through the conductor and the dielectric medium. This difference in inductive vigour results in a return of a portion of the charge to these adjacent surfaces, and this increases rapidly as the bodies are further separated and the dielectric resistance increased. No matter how closely two such bodies may be brought together, there is still a slight resistance, and thus a remnant of charge. And even in the interior of the best conductor a slight resistance exists. Therefore the inductive effects cannot be exactly balanced, even within the interior of a good conductor, except at its central portion. For near one surface the induction from that surface is at its strongest, that from the opposite surface at its weakest, since the latter has felt the resistance of all the molecules of the mass. Thus there is a slight difference in effect, and the surface charge may slightly penetrate into the interior. In good conductors, however, this effect is perhaps inappreciably small.

The same principles apply to the contiguity of two oppositely charged conductors. Each acts upon the other as if

upon an uncharged body. In each positive electricity is induced upon one surface, negative upon the opposite. This induced energy, being added to the pre-existing charge, results in a reduction of this charge upon one surface, and its augmentation upon the other. The effect seems to be a disturbance by the positive body of the negative charge of the other, and an attraction of an excess of it to the adjacent surface; and a reverse attraction of the positive charge by the negative body. But the real effect is unquestionably that above described, each body producing an inductive effect upon the other without regard to its charge, and this effect being added to or deducted from the charge.

(To be continued.)

II. A HANDFUL OF "NUCES ZOOLOGICÆ," AND THEIR "CRACKING."*

By J. W. Slater.

WHO has not seen, or at least heard of, animals, when in some position of real or imaginary danger, shamming death? A fox, after being shot at and wounded, has been known to lie motionless and inert, and to give no sign of life even if handled and lifted up. But if left unnoticed for a time he has been found to have disappeared. The pretended death of the opossum has become proverbial. A dung-beetle, if surprised away from his burrow, stretches out his legs in the stiff and ungainly posture which his race take when dead. Numbers of other Coleoptera, if startled by the approach of a hand, by a passing shadow (as of a bird flying over), fold in their legs close to their body, and remain motionless, or perhaps drop from the spray, tree-trunk, or wall on which they may have been sitting, and may easily be mistaken (*e.g.*, *Byrrhus pilularius*) for a little lump of dirt. Such instances might be multiplied to an indefinite extent were there any question about the facts themselves. But the difficulty lies elsewhere. Why do such

* Trance and Trancoidal States in the Lower Animals. By G. M. Beard, A.M., M.D. New York: W. L. Hyde and Co.

animals counterfeit death? Here we have a variety of theories more or less ingenious. In the fox and the opossum such conduct is generally pronounced a stratagem, consciously and intentionally adopted in the expectation that their captors or enemies, human or brute, may be thrown off their guard, and may thus allow the victim a chance of escape. I am not prepared to deny that this may be at times actually the case. But in a majority of instances "sham death" finds, as will be seen below, a simpler explanation.

With insects, many naturalists still take refuge in the cabalistic word "instinct." The stratagem has been, it is contended, either Divinely implanted in these creatures for their protection, or else it has been developed in them by "natural selection." But does it protect? The insect which drops apparently lifeless from a twig or flower may certainly escape an approaching bird, and is quite as likely to fall into the web of a spider, where its death-like attitude will avail it little. It has been said that rooks, magpies, jays, and the like, will not pick up a dead beetle, and that these insects may often be left unnoticed by their taking the attitude of death. This supposition, if it ever holds good, is not universally correct. When conducting some experiments at the Leeds Sewage Works, in the summer of 1876, I saw a dead *Geotrupes stercorarius* lying on the ground near one of the tanks, with his legs extended as ungracefully as the limbs of a mediæval saint in an illuminated manuscript. I picked him up, satisfied myself that he was really dead, and threw him down again. Soon afterwards I saw a flight of rooks parading about near where the dead beetle was lying, and on again making the circuit of the tanks I saw that his dead body had been pecked to pieces, and that all the soft parts had been eaten. Hence I conclude that rooks will eat dead beetles, and that as against them "shamming death" is not of the slightest use as a means of protection. I submit therefore that the "protective instinct" theory does not hold good.

There are certain other admitted facts which often do duty not as proofs of animal intelligence, but of its very antithesis—animal stupidity. It has been proved, by a number of authenticated cases, that animals placed in great and unwonted danger seem to lose all traces of their ordinary sagacity, and instead of taking a very easy way of escape they remain rooted to the spot, or even rush headlong into destruction. Many painful instances have shown how difficult it is to get horses out of a burning stable: so far from

coming out when the door is set open, they refuse even to be dragged out. Cats, for all their caution and agility, have been known to rush right into a burning house, though many ways of escape were open.

Many years ago, when on the ridge of a mountain in Austria, I saw a fox appear out of a thicket and run along a track leading straight down the slope. As no divinity hedges in the life or the well-being of Reynard in the Dual Monarchy, I took the liberty of setting a large fragment of rock rolling down after him. He fled in terror, but still kept in the same track, and not until the stone was close upon him did he bound to one side, and with a loud yelp disappear in the bushes.

In the year 1879 I noticed a dog fleeing along the Aylesbury and Buckingham Railway, just in front of a train. At any point, by turning to the right or the left, he could have escaped all danger, but he still ran straight on and was almost overtaken. The engine-driver, espying him, slightly reduced speed, when the dog at last came to his senses sufficiently to turn at a level crossing and run along a lane, still plainly in a state of the greatest affright.

Are these and similar events proofs of animal stupidity, or are they not rather to be referred to the same cause as the appearance of death above mentioned?

Another somewhat allied class of phenomena here suggest themselves. The strange influence which a bright light displayed amidst darkness has upon many insects, birds, fishes, and even some mammals, is a most familiar fact. This attraction towards light is particularly experienced by nocturnal animals; but diurnal species, if travelling in the night, are similarly affected. The importunity with which insects will rush towards and seek to force their way into a flame has been utilised not merely for the capture of rarities, but has been applied on the large scale for the destruction of noxious species. Birds are frequently known to dash themselves—sometimes fatally—against the windows of a lighthouse, and this takes place not merely in storms, but in fine weather. Owls have been known to flutter against the windows of a sick chamber in the night. This has been superstitiously regarded as an omen of death, and certain *demi-savans*—seeking to explain away this piece of folk-lore—have made matters worse by suggesting that the owl smells the approach of death, and comes in the hope of feasting on the body. To this theory there are two fatal objections: the owl hunts by the eye, not by scent, and, so

far from being attracted by decomposing animal matter, it will eat nothing which has the slightest taint.

Fish are often caught from a boat carrying torches. The fishes sometimes leap on board, or else are attracted sufficiently near to be speared or captured with a landing-net or by hand.

Certain Mammalia, such as deer, are sometimes—according to Dr. Beard—shot in the night by the aid of a strong light fixed on the hat of the hunter, or in the bow of a boat which is pulled along the shore of a woodland river. Says Dr. Beard, "The conditions for success in this sport are a light boat with boatmen in the stern who pull in a noiseless manner: the hunter in the bow of the boat must also keep perfectly still, holding himself in position to be in readiness to shoot whenever the deer at the water's edge becomes dazed by the light. Other animals are sometimes hunted in the same way."

The attempts at explaining this attraction of light have, so far, not been too happy. The propensity to rush into a fire is so manifestly to the disadvantage of the animals concerned that the "instinct" abracadabra has not here been tried. Some naturalists have suggested that the moth takes the flame of the lamp for an opening through which it may escape into the light. But moths and nocturnal insects generally are quite at home in the dark, and remain during the day dormant. Why should they seek to escape into what they otherwise avoid?

Another suggestion, on the attempted verification of which I have spent no little time, is this:—All flowers are in the night phosphorescent to the delicate vision of insects, who consequently where they see light expect to find honey. Notwithstanding the flaw in this hypothesis, that many insects and birds which are attracted by a light do not feed upon honey or pollen, I have tested it experimentally by trying the effects of phosphorescent light upon insects, and by endeavouring to prove whether flowers generally, after exposure to sunshine, became phosphorescent during darkness. In neither respect were the results decisive. Hence it is satisfactory to find the light-seeking of nocturnal birds, fishes, and insects accounted for on a simple principle which applies to all cases.

There are, it must be remembered, other nocturnal animals upon which a light acts in a different manner. Instead of being attracted, they are put to flight. The flame is recognised as something unusual and to be avoided, but it does not daze and bewilder. This is the case with most of the

larger beasts of prey, and with many serpents. I have read, on doubtful authority, of a Brazilian snake which—instead of being either repelled or stupefied by a fire kindled in the forests—endeavours to extinguish it by knocking the burning sticks asunder.

Another puzzling phenomenon is the alleged fascination exercised by serpents, to which some men are even said to have found themselves subject. The facts here have been called in question. Still a number of witnesses, generally trustworthy, tell us that they have seen birds, frogs, squirrels, &c., remain as if paralysed on the approach of a serpent, and in some cases even rush into its jaws. Some persons declare that they have been unpleasantly affected by the cold, fixed, stony glare of a serpent's eyes, and have felt a kind of torpor steal over them which it required a strong effort of the will to overcome. Experimentally I have repeatedly fixed my eyes on those of serpents, but have felt nothing of the sensation above mentioned. One element, however, was wanting to make the experiment complete: I felt no mysterious dread of the serpents.

Not alone snakes, however, but many predatory animals, are said sometimes to paralyse their intended prey by a fixed gaze, though here, too, decisive cases are wanting.

In a very similar manner the fixed gaze of the human eye has unquestionably a peculiar effect upon many animals,—such as lions, tigers, leopards, &c.,—and has often deterred them from making an attack. Dr. Beard refers to the case of a "lion-tamer" who was accidentally torn to pieces by a leopard during one of those foolish and reprehensible performances which prove, by their popularity, that the taste for the games of the old Roman circus is by no means absent in this virtuous community. We come as near to them as the law allows, hoping in our heart of hearts that some accident will supply that little *soupçon* of blood which seems to complete the relish craved for by the multitude.

To what species this deterrent effect of the human eye extends is a point not yet determined. I doubt whether it would have any effect upon a bear, a wild boar, a Cape buffalo, or a gorilla. Certainly it has no action upon that semi-human being the British rough, at least when assembled in a group. Men of the world generally agree that one of the most essential precautions to escape injury, when meeting a gang of such ruffians in a lonely place, is to avoid catching the eye of any of them.

We are naturally reminded here of the superstition of the

"evil eye," still widely prevalent in the Mediterranean Basin, in Eastern Europe, and in many parts of Asia.

A fixed gaze was in the Middle Ages accounted one of the many means by which the sorcerer, or the fiend in human shape, could gain power over his intended victim. In the witch-trials it was a principle that the judges should particularly avoid catching the eye of the accused, lest they might lose the power of condemning, or of passing a sufficiently rigorous sentence.

Serpent-charming is another curious fact. Setting aside the jugglery and the downright fraud with which the question has been complicated, there seems to be little doubt but that by the production of certain shrill but monotonous sounds, such as whistling, the most vicious snakes—*e.g.*, the redoubtable cobra—can be drawn from their holes and lulled into a dreamy state, during which they are harmless. The iguana, a large lizard found in the tropical regions of the western continent, is captured by means of whistling. The lizard listens intently, and ceases to pay attention to anything else, till a noose is slipped round his neck.

These facts are naturally connected with certain phenomena which have been experimentally produced both in the lower animals and in man, and upon which no little nonsense has been talked and written.

It was at one time a not uncommon trick to lay a hen upon a table, with her breast, neck, and the under side of her beak resting flat upon the surface, whilst a chalk line was drawn upon the table from the point of her beak onwards. On the operator removing his hands the bird generally remained motionless in this awkward position, squinting ludicrously at the chalk line. This experiment is now never performed, and may, for anything I know, fall within the provisions of the well-known Vivisection Act.

Very similar results may be produced both on birds and mammals. The subject operated upon is bewildered by finding itself temporarily placed in some unusual position where motion is impossible, and on being released it does not offer to move. The horse-taming operations of Rarey and others are referred by Dr. Beard to the same class. He remarks, "The horse is a timid and—save in narrow lines, as in memory of places—a stupid animal, else he could not be so easily frightened and subdued." How widely this assertion differs from the popular view need scarcely be stated; but it has often been noticed that, as regards the lower animals, man is apt to confound docility with intelligence.

Some years ago a series of experiments were publicly performed on human subjects, under the painfully absurd name "Electro-Biology." A small disk of copper and zinc, soldered together, was placed in the hand of the person operated upon, and he was told to fix his eyes and his attention steadfastly upon the metals. After a time a certain proportion of the subjects were found to have lost all power over themselves, and had become mere passive instruments in the hands of the operator. A boy in this state was told that he was in darkness: on holding a candle to his face the pupils of his eyes did not contract in the least. These results were ascribed to Electricity, which is invoked to yield an explanation for almost as many ill-observed phenomena as is Instinct. Soon it was found that a disc of a single metal, a coin, a ring, a pebble, a cork, in fact any small object whatever, would answer the same end if persistently gazed at.

All the above phenomena, and many of a similar nature, are referred by Dr. Beard to trance, or a state approaching thereto, for which the author proposes the name "trancoidal" state—an ugly word, for which I should beg to substitute "tranciform." In all such states, of which there are an endless number of stages, the mental equilibrium of the animal is disturbed, so as to cause an increase of nervous activity in some one direction, often to an exhaustive degree, and of course a corresponding suspension of activity in other directions.

Among the means of promoting this disturbance of mental equilibrium, Dr. Beard enumerates—

1. Acting on the emotion of fear by reducing the animal to helplessness, by tying or confinement of some kind.

   Here, of course, belong the horse-taming feats of Rarey, elephant-taming according to W. H. Cross, and the experiments with birds above mentioned.

2. Making strokes or "passes" on or over an animal.

   Here we have animal magnetism.

3. Steadily fixing the eyes on those of some other person or animal.

   Under this head come lion-taming, tiger-repelling, the evil eye, the fascination exerted by serpents, &c.

4. Presenting to the animal a bright light.

   Under this head fall the refusal, or, more accurately speaking, the temporary inability, of horses, cats, and even men, to escape from burning stables, houses, churches, theatres, and the like. It may be here remarked, in passing, that presence of mind is

the absence of liability to have the equilibrium of nervous activity disturbed.

5. Vocal or instrumental music, as shown in serpent-charming, lizard-catching, the efficacy of music in the treatment of mental disease, &c.

Dr. Beard remarks that the only difference between what is called absent-mindedness and the decided trance, in which a person or other animal may remain unconscious even for years, is one of degree. He deserves the warm thanks of naturalists for the light he has thrown on some of the most obscure facts of animal psychology, and for the clean sweep which he has made of certain plausible superstitions.

III. AN ESTIMATE OF AUGUSTE COMTE.

By G. H. C.

SOME thirty years ago the English public was told, by a brilliant and versatile writer, of one who was proclaimed to be "the greatest thinker of modern times," —a man whose doctrine was to the nineteenth something more than that which Bacon's was to the seventeenth and eighteenth centuries." The world heard,—some in undisguised alarm lest the new philosophy should be merely "infidelity" under a fresh disguise. Others listened with eager hope, and a few perhaps with critical reserve. My task to-day is, leaving religious and political speculations to more specially qualified hands, to enquire what has been the outcome of this "Positive Philosophy" as far as Science is concerned? It is well known that Comte did not intend or attempt to furnish in his great work a series of treatises on the various sciences; but he sought to display them in their mutual relations, as a coherent hierarchy, arranged on natural principles. He sketched their history, their present position, and in some sort their future prospects, and expounded their methods, their leading doctrines, and the part each has to play in the education of mankind. No one can dispute either the difficulty or the importance of the undertaking, which if performed aright must have given a powerful

impulse to every science, and been of the greatest value to every inquirer.

To ascertain how far Comte can be pronounced successful in the execution of his task, we must examine his three guiding conceptions:—

He regarded "all the sciences, physical and social, as branches of one Science, to be investigated on one and the same method." The originality of this conception is not very apparent. For a couple of centuries the current of thought had been decidedly moving in that direction; but no one, as far as I am aware, had previously formulated the idea with Comte's distinctness.

The second fundamental conception is proposed as the supreme law of human development:—"There are but three phases of intellectual evolution, for the individual as well as for the mass—the theological (supernatural, or, as I should prefer to say, the personifying), the metaphysical, and the positive." In the first of these stages man seeks the ultimate and final causes of everything. It supposes all surrounding objects animated or sentient. It is curious, I remark, in passing, how this ascription of life and consciousness to all matter is again creeping in among men of high intelligence. In the metaphysical phase phenomena are referred to abstractions or entities, and in the positive phase the mind confines itself to a quest into the laws of phenomena, superadding nothing to what is observed, and dismissing causes and entities as beyond human scope.

It cannot be denied that numbers of instances can be found which seem to agree beautifully with this law. The explosive gas which in our days sometimes shatters a mine, and buries the unfortunate workmen, was in former ages an angry demon, a gnome, or cobold, jealous of human intrusion into his treasure-houses. The fact that the ordinary pressure of the atmosphere counterbalances a column of 32 feet of water, and no more, was at one time explained by the dictum that Nature abhorred a vacuum for the first 32 feet, but not beyond. But on a careful analysis of the rise and progress of Science we do not find these stages as above indicated. Liebig was unable to trace them in the history of chemistry. If we refer to the earliest known documents concerning that science, such as the "Book of the Balance of Wisdom,"* we shall find the records of calm, experimental inquiry, distinctly "positive" in its spirit, and free from anything mystical or fantastic. The strange superstitions and delu-

* Journal of Science, 1876, p. 494.

sions with which we are all so familiar seem to have attached themselves parasitically to the science at a later date.

Or, if we turn to the medical art, the "Papyrus Ebers," dating from the sixteenth century B.C., is "free from hocus-pocus and gibberish. Sorcery was forbidden in the strictest manner, and the alchemistic magi were punished with death under Ramesis III."

Mr. Herbert Spencer, after a careful examination of the genesis of Science, rejects the Comtean phases as specially significant.*

Comte's classification of the sciences is to begin with the most simple and general phenomena, and to proceed to the most complex and particular. The sciences are thus arranged according to their mutual dependence.

Here, also, we are on doubtful ground. If we arrange the so-called primary sciences in Comte's series,—mathematics, astronomy, physics, chemistry, biology, sociology, there is no doubt that those which come later in the rank are indebted to the earlier ones both for methods and for facts, and that the more the nearer they stand together. But there is also indebtedness in the opposite direction. Astronomy is beholden to physics and chemistry for methods of investigating the temperatures, the nature, and even the movements of the heavenly bodies. Biology supplies chemistry with means of determining the molecular constitution of compounds.†

Such cases of mutual obligation are sure to increase. Again, the phenomena of physics are quite as "general" as those of astronomy, since we only recognise the heavenly bodies by the light which they emit or reflect. It is also difficult to conceive that we can anywhere have matter acted on by certain of the forms of energy, such as heat, light, and electricity, without chemical change. Chemical phenomena are thus found co-extensive with those treated of by astronomy and physics.

It would almost appear, from several passages in Comte's works, as if he regarded the general as in its nature higher than the special. We who have been accustomed to trace out how an organism rises by specialisation can scarcely accept a line of reasoning which leads him to conclude that the bookseller deserves a higher rank than the author, the picture-dealer than the artist, and the drysalter than the manufacturer who prepares some delicate colour.

Let us now take a brief survey of Comte's summary views

* Mathematics cannot have had a truly theological or a metaphysical phase.
† *See* Journal of Science, 1881, p. 318.

of certain of the sciences, that we may see what services he has really rendered.

In physics Comte rejects the so-called imponderables. He does not admit, nor does he deny, the existence of the so-called ether whose undulations affect our senses as light. Some credit may belong to him for taking this stand, when it is remembered that at the time when the "Philosophie Positive" was written (1830—1842) many French thinkers still clung to the conception of "caloric" as a substantive entity.

Comte's classification of the respective branches of physics —based professedly, as usual, on "the degree of generality of the corresponding phenomena, on the extent of their complication, their relative states of speculative perfection, and also their mutual dependence"—is not happy. His order is barology, thermology, acoustics, optics, and electricity. It must surely be admitted that the phenomena of light and electricity—the former of which agencies travels through the interstellar spaces, whilst the latter probably pervades all matter—are far more general than those of sound. The classification of the sciences in a linear series, on any principles, will be found practicable only by dint of arbitrary assumptions and by the neglect of obvious considerations.

Electricity Comte considers as forming a natural transition to chemistry. Yet the relations of chemistry and heat are now found no less intimate. Indeed he seems to have little foreseen how physics and chemistry would approximate and almost coalesce in the half-century succeeding the date of his first volume. It is no longer safe to say "Physics treats of masses acting at sensible distances; chemistry treats of molecules acting at insensible distances." In physics we meet with abundant cases of molecular action. Nor are specific differences wanting in the physical properties of bodies. We may take three crystals, one of which, in virtue of its molecular structure, shall cause the plane of polarisation to rotate to the right, the second to the left, whilst the third leaves it unaffected!

Comte maintains that dualism requires to be universally received in chemistry ("Philosophie Pos.," iii. 103—9), even as regards organic compounds. Here, then, we have a want of insight into the future prospects of a science scarcely less striking than he displays in biology by his denial of the mutability of organic species. It is perfectly true that in 1838 dualism was still in the ascendant, but indications were not wanting which might have been sufficient for a man of such

penetrating intellect as Comte is represented by his admirers. Men of the most ordinary stamp can recognise a change when it is formally introduced. From the leading thinkers of the age we expect the power of detecting its first approaches.

We come next to biology, the doctrine of life, which, according to Comte, includes psychology, We cannot take exception to the place which he assigns it, immediately after chemistry and before sociology. He rightly and boldly rejects the standard definitions of life, especially that of Bichat, which cannot be held other than ridiculous:—"Life is the sum of the functions by which death is resisted." But as "death = the termination of life" we may, by introducing this explanation in place of the original term, convert this would-be definition into "Life is the sum of the functions by which the end of life is resisted!" The definition which Comte prefers is that of De Blainville:—"Life is the two-fold internal movement of composition and decomposition, at once general and continuous." It may, however, be urged that no definition of life can be at all complete unless it includes the idea of reproduction. It may further be asked whether the very attempt to define life is not in some measure a departure from the principles of positivism? We may ascertain the conditions, the laws, the properties of life, but questions as to its nature and its purpose seem to belong to an order which Comte declines to attack.

He decomposes the unhappy discipline formerly known as "organic chemistry," and assigns one part of its subject-matter to chemistry, properly speaking, and the remainder to biology. He regards tissues as being to the animal and plant what molecules are for the chemical compounds. He objects to the life-monads of the physio-philosophers. On the doctrine of cells he is silent. But it must be particularly and regretfully noted that he does not accept the ideas of his great countrymen Buffon and Lamarck, but regards animal and vegetable species as fixed and permanent. He does not, of course, tell us that species were either created as we now find them, or came into existence spontaneously, or that they have existed for ever. To have made such an attempt would have been a departure from the principle which he holds in common with Whewell, Humboldt, and Herschell, that Science does not legitimately deal with origins. How much he has thus missed by failing to appreciate the doctrine of Evolution—a principle which may in future prove no less fruitful in sociology than it has already done in biology—it is not easy to sum up. Had he done so he might have given

a most valuable impulse to organic science. Acting as he did he has given a proof of deficiency in profound philosophic insight; in the spirit which anticipates the future track of discovery. More than this, he has thrown his weight into the scale of the reactionary school of Cuvier. Unless I am greatly misinformed many of the "Positivists" in England and France still think it necessary to reject Evolution. For all this certain sages in England have a hazy kind of notion that "Monsieur Comte" is, in some circuitous manner, an accomplice of Darwin! Did Comte ever take the trouble to give Lamarck's writings a fair examination? An interesting by-question might here be raised: why has France, unlike Britain, Germany, and America, taken so little part in the cultivation of the New Biology? It cannot be entirely due to the personal influence of two eminent naturalists, one of them long ago dead and the other still living. I read lately an anonymous article in which a French zoologist complains of the low position to which the science has fallen in consequence of official alethophobia.

One of the peculiarities of Comte is that he denies to psychology the rank of an independent science. Here it must not be overlooked that he is not followed by his expositor, G. H. Lewes, nor by his admirer (in many respects), John Stuart Mill. Both these writers contend that, should mind be ultimately proved to be merely a function of the nervous centres, the successions and co-existences of mental states are capable of being directly studied without reference to the cerebral changes which may be their immediate antecedents. Even if life is simply a play of matter, thought is a higher phase of life, displaying special phenomena, and admitting, or rather requiring, special study.

We come here to a consideration of Comte's phrenology. Rejecting the ordinary craniological system as originated by Gall, he still holds to the principle that the brain consists of a number of distinct organs, each the seat of some particular faculty. But he assigns each faculty its seat not in consequence of comparative observations, but, as I cannot help saying, arbitrarily,—*i.e.*, according to his own notions as to where they ought to be fixed,—and leaves to anatomists the task of discovering evidence in favour of his system, which so far has not been forthcoming. It is scarcely necessary to say that the Comtean phrenology has to encounter all the difficulties which beset the system of Gall, without its empirical evidence. The two are not in harmony. Comte places the nutritive and the sexual instinct (alimentiveness and amativeness of Gall), the former in the centre of the

cerebellum and the latter in its sides. Benevolence he places at the highest point of the cerebrum, and veneration immediately behind it. It is to be noticed that Comte does not commit the error of denying to animals the possession of the moral sentiments, as do some phrenologists, despite the evidence of these sentiments in their conduct, and despite the fact that their brains—*i.e.*, those of the anthropoid apes—do not differ from our own in the manner and to the extent which this assumption would require.

Now let us turn to the last member of the hierarchy,—sociology. Comte certainly proclaimed that human society had its inherent laws, not dependent upon the caprice of rulers or statesmen, or upon the exertions of demagogues or stump-orators; laws capable of being discovered by the very same methods which we are successfully following in chemistry or in biology.* Few competent judges will here join issue. But has he really placed in our hands a clue capable of being followed up? Are we making any definite progress? Look, for instance, at our Social Science Congress, well characterised as an assemblage "of men who ought to have been women, and of women who wish to be men." Its Transactions are filled not with the attempt to reduce social phenomena under laws capable of verification, and leading to the prevision of facts not yet observed, but with an *olla podrida* of declamation on every subject that can be construed as having any reference to human society, with rhapsodies on sewage-irrigation, woman's rights, coddling criminals, infectious diseases, anti-vaccination, trades'-unionism, and the like,—the whole floating in an opaque and lukewarm whey of self-complacency and mutual admiration. Comte to blame for all this? By no means; but that such farces can still be enacted under the name of "social science" shows that a definite plan has not yet been drawn out.

On no ground has Comte been more strongly and more unjustly denounced than anent his rejection of "political economy." He condemns it as the outcome of a merely critical and negative philosophy, isolating itself from the whole to which it should rightfully belong, and seeking to take its place. In his rejection he seems, however, to me to have been guided by a correct principle. For what is, after all, political economy? Simply the study of man viewed solely as a producer, accumulator, distributor, and

* I cannot find that Comte anywhere recognises the necessity of studying the simpler societies of the lower animals before proceeding to examine the more complicated polity of our own species. Yet he elsewhere lays down principles from which the importance of such a step would plainly follow.

consumer of wealth, all his other functions being disregarded. That such disregard is temporarily justifiable as a scientific artifice for the sake of more convenient study is indisputable. But how if this disregard is carried out into practice? Let me take a parallel case. Let us suppose that nothing were known concerning the anatomy and physiology of man, and that the art of healing had been followed empirically, practitioners observing that when certain symptoms were recognised benefit was obtained by the use of this or the other remedy or appliance. Under such circumstances, if a body of men came to the conclusion that a knowledge of the human system with its various functions were to be desired, it would be perfectly legitimate for them to confine themselves temporarily to the study of some one set of organs. They might, for instance, select in this manner the respiratory apparatus and its laws of action. The truths they might thus ascertain would be, if rightly applied, of great value in medical practice. But suppose that, having reached a moderately accurate knowledge of respiration and its organs, they declined to investigate other functions of the body, and attempted to heal the sick in the sole light of their recent studies, declaring, tacitly at least, that so long as the lungs of a patient were kept in healthy action, the digestive, the circulatory organs, and even the nervous centres might be safely neglected, the result would be quackery of the worst type. But, *mutatis mutandis*, this is precisely what the economists do in attempting to reduce their fraction of a science to practice. Comte felt this, and hence his condemnation of the economists was legitimate.

He proclaimed that the military ecclesiastic *régime* is to be replaced by an industrial and scientific organisation, the workman succeeding to the soldier and the *savant* to the priest. But it does not appear whether he ever asked himself if industrialism is or should be the final haven of the human race. I doubt whether it would be possible to point out a manufacturing and commercial city, province, or country where wealth, either for the few or the many, has not been bought at the price of personal degeneration, physical, moral, and intellectual. Whether industry can ever be so re-organised as not to yield these bitter fruits,—whether it will ever allow man the quietude and the leisure which are absolutely necessary for his full development,—I dare not even guess. Certainly we are not moving in that direction.

It is doubtful whether we can pronounce Comte a friend to Science. He was certainly no discoverer. Though he

assigns to scientific men, or at least to philosophers in his sense of the word, a position something like what was formerly held by the priesthood, he subordinates Science to Emotion. In the words of his whilom interpreter, he considers the "intellectual aspect not the noblest aspect of man." He maintains that "Science is a futile, frivolous pursuit, unworthy of greater respect than a game of chess, unless its issue be in some enlarged conception of man's life and destiny." In other words, he did not feel that love of abstract truth for its own sake, quite independent of man, which actuates the bulk of our great investigators. If Science was not to him exactly—

"Eine tüchtige Kuh die ihn mit Butter versorgt,"

as she is to most of our practical men, who for all that begrudge her pasture, she is, on the other hand, not—

"Die hohe, die himmlische Göttinn."

Here I must avow my dissent. For what is man but a thinking brain, furnished with outward senses as its messengers, with limbs as its agents, and with digestive, circulatory, respiratory, &c., organs to maintain its activity? The lower animals have wills, emotions, but they have no Science; in them the intellect is a servant. In man alone, or at least in the higher man, the relation is inverted. He does not perceive and understand to live, but he lives to perceive and understand the world in which he is placed.

The "Positive Philosophy" can scarcely, as time passes on, and as the excitement which greeted its avatar dies away, be pronounced as marking out any grand epoch in the intellectual history of the world. In comparison with the doctrine of development it appears scantily fruitful in consequences. In its case, as in so many others, results stand in no definite relation, either quantitative or qualitative, to intentions. Just as the advocates of peace have before now brought on a bloody war,—just as the philanthropist often finds that he has been multiplying misery,—just as the enthusiasts who seek to unite all Christian communities into one, simply succeed in generating a new heresy and a new intolerance, so it has been with the doctrine which was to have absorbed all intellectual activity into one harmonious system.

IV. PHYSIOLOGY OF MIND-READING.

By George M. Beard, M.D.

AS "thought-reading" or mind-reading is now being exhibited in this country as an unexplained novelty, and is exciting much sensation, we have great pleasure in inserting the following paper by Dr. G. M. Beard, which, though it had been already published in the "Popular Science Monthly" (February, 1877), has just been sent to us by the author along with an important letter, dated May 31st, from which we extract the following passages:—

"Dr. Carpenter's course in this matter is, as it seems to me, hardly worthy of a scientific man, for he has long been familiar with my investigations in this department; indeed he sent to me for my original papers about two years ago, and he complimented me, in as high terms as one scientific man can bestow upon another, for the original work that I had done in this and allied departments of science. Now when the subject is brought up he nowhere recognises my discoveries which previously he had quoted with high approval, but allows the credit to fall upon himself by implication, or lets the matter remain undecided.

"I have written a letter to the "Lancet" on the subject, and have also sent them a copy of this essay, which was published in 1877.

"Irving Bishop was in America at the time I was making my researches, and had conversations with me about them, and gained what he knew from my studies and from the performances of 'Brown the mind-reader.'"

In the history of science, and notably in the history of physiology and medicine, it has often happened that the ignorant and obscure have stumbled upon facts and phenomena which, though wrongly interpreted by themselves, yet, when investigated and explained, have proved to be of the highest interest. The phenomena of the emotional trance, for example, had been known for ages; but not until Mesmer forced them on the scientific world, by his public exhibitions

and his ill-founded theory of animal magnetism, did they receive any serious and intelligent study. Similarly the general fact that mind may so act on body as to produce involuntary and unconscious muscular motion was by no means unrecognised by physiologists, and yet not until the "mind-reading" excitement two years ago* was it demonstrated that this principle could be utilised for the finding of any object or limited locality on which a subject, with whom an operator is in physical connection, concentrates his mind.

Although experiments of this kind had been previously performed in a quiet limited way, in private circles, yet very few had heard of or witnessed them; they were associated in the popular mind very naturally with "mesmerism," and by some were called "mesmeric games." The physiological explanation had never been even suggested; hence the first public exhibitions of Brown, with his successful demonstrations of his skill in this direction, were a new revelation to the scientific world in general.

The method of mind-reading introduced by Brown, which is but one of many methods that have been used, is as follows:—

The operator, usually blindfolded, firmly applies the back of the hand of the subject to be operated on against his own forehead, and with his other hand presses lightly upon the palm and fingers of the subject's hand. In this position he can detect, if sufficiently expert, the slightest movement, impulse, tremor, tension, or relaxation, in the arm of the subject. He then requests the subject *to concentrate his mind* on some locality in the room, or on some hidden object, or on some one of the letters of the alphabet suspended along the wall. The operator, blindfolded, marches sometimes very rapidly with the subject up and down the room or rooms, up and down stairways, or out-of-doors through the streets, and, when he comes near the locality on which the subject is concentrating his mind, a slight impulse or movement is communicated to his hand by the hand of the subject. This impulse is both involuntary and unconscious on the part of the subject. He is not aware that he gives any such impulse; and yet it is sufficient to indicate to the expert and practised operator that he has arrived near the hidden object, and then, by a close study and careful trials in different directions, upward, downward, and at various points of the compass, he ascertains precisely the locality, and is, in many cases, as confident as though he had received

* *I.e.* 1875.

verbal communication from the subject. Even though the article on which the subject concentrates his mind be very small, it can frequently be picked out from a large number, provided the subject be a good one, and the operator sufficiently skilful. The article is sometimes found at once, the operator going to it directly, without hesitation, and with a celerity and precision that, at first sight, and until the physiological explanation is understood, justly astonish even the most thoughtful and sceptical. These experiments, it should be added, are performed in public or private, and on subjects of unquestioned integrity, in the presence of experts, and under a combination of circumstances and conditions for the elimination of error that make it necessary to rule out at once the possibility of collusion.

The alternative is, therefore, between the actual transfer of thought from subject to operator, as has been claimed, and the theory of unconscious muscular motion and relaxation on the part of the subject, the truth of which I have demonstrated by numerous experiments.

One of the gentlemen with whom I have experimented, Judge Blydenberg, who began to test his powers directly after I first called public attention to the subject in New Haven, claims to succeed, even with the most intellectual persons, provided they fully comply with the conditions, and honestly and persistently concentrate their minds. One fact of interest is the exceeding minuteness of the objects that he finds. A large number of the audience empty their pockets on the table, until it is covered with a medley of keys, knives, trinkets, and miscellaneous small objects. Out of them the subject selects a small seed a little larger than a pea, and even this the operator, after some searching, hits precisely.

One may take a large bunch of keys, throw them on the table, and he picks out the very one on which the subject concentrates his mind.

Another fact of interest in his experiments is that, if the subject thinks over a number of articles in different parts of the room, and finally selects some one, the operator will lead him, sometimes successively, to the different objects on which he has thought, and will wind up with the one that he finally selected. He also performs what is known as the "double test," which consists in taking the hand of a third party, who knows nothing of the hidden object, but who is connected with another party who does know, and who concentrates his mind upon it. The connection of these two persons is made at the wrist, and the motion is communi-

cated from one to the other through the arms and hands. The "double test" has been regarded by some as an argument against the theory that this form of mind-reading was simply the utilising of unconscious muscular motion on the part of the person operated upon.

This gentleman represents that the sensation of muscular thrill is very slight indeed, even with good subjects; and, in order to detect it, he directs his own mind as closely as possible to the hand of the subject.

In all these experiments, with all mind-readers the requirement for the subject to concentrate the mind on the locality agreed upon is absolute; if that condition is not fulfilled, nothing can be done, for the very excellent reason that, without such mental concentration, there will be no unconscious muscular tension or relaxation to guide the operator.

I have seen a performer—far less skilful than many with whom I have experimented—take a hat from the head of a gentleman in a small private circle, and carry it across the room and put it on the head of another gentleman; take a book or any other object from one person to another; or go in succession to different pictures hanging on the wall, and perform other feats of a similar character, while simply taking hold of the wrist of the subject. In the experiment described by Mr. Grimes the subject placed three fingers of his right hand on the shoulder of the operator. Note the fact that in all these experiments *direction* and *locality* are all that the mind-reader finds; the quality of the object found, or indeed whether it be a movable object at all, or merely a limited locality, as a figure in the carpet or on the wall, is not known to the mind-reader until he picks it up or handles it: then if it be a small object, as a hat, a book, a coin, or tidy, he very naturally takes it and moves off with it in the direction indicated by the unconscious muscular tension of the subject, and leaves it where he is ordered by unconscious muscular relaxation. In the great excitement that attends these novel and most remarkable experiments the entranced audience fail to notice that the operator really finds nothing but *direction* and *locality*.

I have said that various errors of inference, as well as of observation, have been associated with these experiments. A young lady who had been quite successful as an amateur in this art was subjected by me to a critical analysis of her powers before a large private audience. She supposed that it was necessary for all the persons in the audience to concentrate their minds on the object as well as those whose

hands were upon her. I proved by some decisive experiments, in which a comparison was made with what could be done by chance alone, that this was not necessary, and that the silent, unexpressed will of the audience had no effect on the operator, save certain nervous sensations created by the emotion of expectancy. Similarly, I proved that, when connected with the subjects by a wire, she could find nothing, although she experienced various subjective sensations, which she attributed to "magnetism," but which were familiar results of mind acting on body.

Another lady, who is quite successful in these experiments, thought it was necessary to hide keys, and supposed that "magnetism" had something to do with it. I told her that that was not probable, and tried another object, and found that it made no difference what the object was. She supposed that it was necessary that the object should be secreted on some person. I found that this also was not necessary. She does not always succeed in finding the exact locality at once, but in some cases she goes directly to it; she very rarely fails.

In order to settle the question beyond dispute whether unconscious muscular action was the sole cause of this success in finding objects, I made the following crucial experiments with this lady:—Ten letters of the alphabet were placed on a piano, the letters being written on large pieces of paper. I directed her to see how many times she would get a letter which was in the mind of one of the observers in the room correctly by chance purely, without any physical touch. She tried ten times, and got it right twice. I then had her try ten experiments with the hand of the person operated on against the forehead of the operator, the hand of the operator lightly touching against the fingers of this hand, and the person operated on concentrating her mind all the while on the object, and looking at it. In ten experiments, tried this day, with the same letters, she was successful six times. I then tried the same number of experiments with a wire, one end being attached to the head or hand of the subject, and the other end to the head or hand of the operator. The wire was about ten feet long, and was so arranged—being made fast at the middle to a chair—that no unconscious muscular motion could be communicated through it from the person on whom she was operating. She was successful but once out of ten times. Thus we see that by pure chance she was successful twice out of ten times; by utilising unconscious muscular action in the method of Brown she was successful six times out of ten.

When connected by a wire she was less successful than when she depended on pure chance without any physical connection. In order still further to confirm this, I suggested to this lady to find objects with two persons touching her body in the manner we have above described. I told these two to deceive her, concentrating their minds on the object hidden, at the same time using conscious motion toward some other part of the room. These experiments, several times repeated, showed that it was possible to deceive her, just as we had found it possible to deceive other muscle-readers.

It is possible to become quite an adept in this art without suspecting, even remotely, the physiological explanation. The muscular tension necessary to guide the operator is but slight, and the sensation it produces may be very easily referred by credulous, uninformed operators to the passage of "magnetism;" and I am sure that with a number of operators on whom I have experimented this mistake is made. Some operators declare that they cannot tell how they find the locality, that their success is to them a mystery. Other operators speak of thrills or vibrations which they feel, auras and all sorts of indefinable sensations. These manifold symptoms are purely subjective, the result of mind acting on the body, the emotions of wonder and expectancy developing various phenomena that are attributed to "animal magnetism," "mesmerism," or "electricity"—to everything but the real cause. I have seen amateurs who declared that they experienced these sensations when trying without success to "read mind" through the wires, or perhaps without any connection with the subject whatever.

The facts which sustain the theory that the so-called mind-reading is really muscle-reading—that is, unconscious muscular tension and relaxation on the part of the subject—may be thus summarised:

1. Mind-readers are only able to find *direction* and *locality*, and, in order to find even these, they must be in physical connection with the subject, who must *move* his body or some portion of it—as the fingers, hand, or arm. If the subject sits perfectly still, and keeps his fingers, hand, and arm perfectly quiet, so far as it is possible for him to do so by conscious effort, the mind-reader can never find even the *locality* on which the subject's mind is concentrated; he can only find the *direction* where the locality is. Mind-readers never tell what an object is, nor can they describe its colour or appearance; *locality*, and nothing more definite than locality, is all they find. Again, where connection of the operator with the subject is made by a wire, so arranged

that mass-motion cannot be communicated, and the subject concentrates his mind ever so steadily, the operator does just what he would do by pure chance, and no more. This I have proved repeatedly with good subjects and expert performers.

2. The subject can successfully deceive the operator in various ways—first of all, by using muscular tension in the wrong direction, and muscular relaxation at the wrong locality, while at the same time the mind is concentrated in the right direction. To deceive a good operator in this way is not always easy, but after some practice the art can be acquired, and it is a perfectly fair test in all experiments of this nature.

Yet another way to deceive the mind-reader is, to think of some object or locality at a great distance from the room in which the experiments are made, and, if there be no ready means of exit, the performer will be entirely baffled. I am aware that some very surprising feats have been done in the way of finding distant out-of-door localities by muscle-readers, but in these cases there has usually been an implied understanding that the search was to be made out-of-doors; muscle-readers have thus taken their subject up and down stairs or from one room or hall into another, and out-of-doors until the house or locality was reached.

Another way in which deception may by practised is for the subject to select some object or locality on the person of the muscle-reader. If such a selection be made, and the method of physical connection above described be used, the experiment will be a failure, provided the muscle-reader does not know or suspect that an object on his own person is to be chosen. Similarly, if the subject selects a locality on his own person, as one of the fingers or finger-nails of the hand that connects with the muscle-reader. When such tests are used, there is not, so to speak, any leverage for the tension of the arm toward the locality on which the mind is concentrated, and the muscle-reader either gets no clue, or else one that misleads him.

3. When a subject, who has good control over his mental and muscular movements, keeps the arm connected with the operator *perfectly stiff*, even though his mind be well concentrated on the hidden object, the operator cannot find either the direction or the locality. This is a test which those who have the requisite physical qualifications can sometimes fulfil without difficulty.

Here I may remark that the requirement to concentrate the mind on the locality and direction sought for all the

time the search is being made is one that few can perfectly fulfil. Any number of distracting thoughts will go through the best-trained mind of one who, in company with a blindfolded operator, is being led furiously up and down aisles, halls, streets, and stairways, fearful each moment of stumbling or striking his head, and followed, it may be, by astonished and eager investigators. And yet these mental distractions do not seem to interfere with the success of the experiment unless the arm is kept studiously rigid, in which case nothing is found save by pure chance. Credulous, wonder-loving subjects are sometimes partially entranced through the emotions of reverence and expectation; with subjects in this state operators are quite sure to succeed.

4. The uncertainty and capriciousness of these experiments, even with expert operators, harmonise with the explanation here given. Even with good subjects all mind-readers do not uniformly succeed; there is but little certainty or precision to the average results of experiments, however skilfully performed. Even in the successful tests the operator usually must try various directions and many localities, sometimes for ten or fifteen minutes, before he finds the locality sought for; cases where the operator goes at once in the right direction, stops at the right locality, and *knows* when he has reached it, are exceptional.

5. Many of those who become expert in this art are aware that they succeed by detecting slight muscular tension and relaxation on the part of the subject.

Some operators have studied the subject scientifically, and are able to analyse with considerable precision the different steps in the process.

6. A theoretical and explanatory argument is derived from the recent discovery of motor centres in the cortex of the brain.

I was repeating the experiments of Fritsch and Hitzig at the time when my attention was first directed to the remarkable exhibitions of Brown, and the results of my studies in the electrical irritation of the brains of dogs and rabbits suggested to me the true explanation of mind-reading before any opportunity had been allowed for satisfactory experiments.

The motto "when we think we move," which I have sometimes used to illustrate the close and constant connection of mind and body, seems to be justified by these experiments on the brain, and may assist those who wish to obtain a condensed statement of the physiology of mind-reading. Taking into full consideration the fact that all physiologists

are not in full accord as to the interpretation to be given to these experiments, whether, for example, the phenomena are due to direct or reflex action, still it must be allowed, by all who study this subject experimentally, that thought-centres and muscle-centres are near neighbours, if not identical.

In all these experiments it should be observed there is no one muscle, there is no single group of muscles, through which this tension and relaxation are developed; it is the finger, the hand, the arm, or the whole body, according to the method employed. Among the various methods of making connection between the subject and operator are the following :—

1. The back of the subject's hand is held firmly against the forehead of the operator, who with his other hand, lightly touches the fingers of the subject's hand. (Brown.)

This is, undoubtedly, the most artistic of all known methods.

2. The hand of the operator loosely grasps the wrist of the subject.

This is a very inartistic method, and yet great success is oftentimes attained by it.

3. One finger of the operator is applied to one finger of the subject, papillæ touching papillæ.

This is a modification of the first method; by it exceedingly small objects or localities are found.

4. The operator is connected in the usual way with a third party who does not know the locality thought of by the subject, but is connected with the subject by the wrist ("double test").

In this experiment, which astounded even the best observers, the unconscious muscular motion was communicated from the subject to the arm of the third party, and through the arm of the third party to the operator.

5. Two, three, or more subjects, who agree on the locality to be thought of, apply their hands to the body of the operator in front and behind.

This method is excellent for beginners, and the direction is easily found by it; but it is obviously not adapted for the speedy finding of small objects; it is frequently used by ladies.

6. The hand of the subject lightly rests on the shoulder of the operator.

In all these methods the operator is usually blindfolded, so that he may get no assistance from any other source than the unconscious muscular action of the subject.

The movements of the operator in these experiments may be either very slow, cautious, and deliberate, or rapid and reckless. Brown, in his public exhibitions, was very careful about getting the physical connection right, and then moved off very rapidly, sometimes in the right direction, sometimes in the wrong one, but frequently with such speed as to inconvenience the subject on whom he was operating. These rapid movements serve, no doubt, in many cases, to bewilder or partially entrance the subject, and thus to render him far more likely to be unconscious of his own muscular tension and relaxation through which the operator is guided.

The power of muscle-reading depends mainly, if not entirely, on some phase of the sense of touch.

Every physician recognises the fact of this difference of susceptibility to touch; and, in the diagnosis of certain conditions of disease, much depends on the *tactus eruditus*. I am not sure whether this delicacy of perception, by which muscle-reading is accomplished, is the ordinary sense of touch, that of contact, or of some of the special modifications of this sense. It is to physiologists and students of diseases of the nervous system a well known fact that there are several varieties of sensibility—to touch, to temperature, to pressure or weight, and to pain—which, possibly, represent different rates or modes of vibration of the nerve-force.

The proportion of persons who can succeed in muscle-reading, by the methods here described, is likewise a natural subject of inquiry. It is probable that the majority of people of either sex, between the ages of fifteen and fifty, could attain, if they chose to labour for it, under suitable instruction, a certain grade of skill as muscle-readers, provided, of course, good subjects were experimented with. It is estimated that about one in five or ten persons can be put into the mesmeric trance by the ordinary processes; and, under extraordinary circumstances, while under great excitement, and by different causes, every one is liable to be thrown into certain stages or forms of trance; the capacity for the trance-state is not exceptional; it is not the peculiar property of a few individuals—it belongs to the human race; similarly with the capacity for muscle-reading. The age at which this delicacy of touch is most marked is an inquiry of interest; experience, up to date, would show that the very young or the very old are not good muscle-readers.

In these mind-reading experiments, as indeed in all similar or allied experiments with living human beings, there are six sources of error, all of which must be absolutely

guarded against if the results are to have any precise and authoritative value in science.

1. The involuntary and unconscious action of brain and muscle, including trance, in which the subject becomes a pure automaton. I have used the phrase "involuntary life" to cover all these phenomena of the system that appear independently of the will. The majority of those who studied the subject of mind-reading—even physicians and physiologists—failed through want of a proper understanding or appreciation of this side of physiology.

2. Chance and coincidences. Neglect of this source of error was the main cause of the unfortunate results of the wire and chain experiments with mind-readers.

3. Intentional deception on the part of the subject.

4. Unintentional deception on the part of the subject.

5. Collusion of confederates. To guard against all the above sources of error it is necessary for the experimenter himself to use deception.

6. Unintentional assistance of audience or bystanders.

When the muscle-reader performs before an enthusiastic audience, he is likely to be loudly applauded after each success; and, if the excitement be great, the applause, with shuffling and rustling, may begin before he reaches the right locality, while he is approaching it; when, on the other hand, he is far away from the locality, the audience will inform him by ominous silence. The performance thus becomes like the hide-and-seek games of children, where they cry "Warm!" as the blindfolded operator approaches the hidden object; "Hot!" as he comes close to it; and "Cold!" when he wanders far from it. Some of the apparent successes with the wire-test may be thus explained.

In regard to all the public exhibitions of muscle-readers, it should be considered that the excitement and *eclat* of the occasion contribute not a little to the success of the operator; the subjects grow enthusiastic—are partly entranced, it may be—become partners in the cause of the performer—and unconsciously aid him far more than they would do in a similar entertainment that was purely private. In a private entertainment of muscle-reading at which I was present, one of the subjects, while standing still, with his hands on the operator, actually took a step forward toward the locality on which his mind was concentrated, thus illustrating in a visible manner the process by which muscle-reading is made possible.

The subject under discussion, it will be observed, is to be studied both inductively and deductively. The general claim

of mind or thought reading is disproved not by any such experiments as are here detailed, no matter how accurate or numerous they may be, but by reasoning deductively from the broad principle of physiology, that no human being has or can have any qualities different in *kind* from those that belong to the race in general. The advantage which one human being has over another—not excepting the greatest geniuses and the greatest monsters—is, and must be, of degree only. Mind-reading, in the usual meaning of the term, is a faculty that in any degree does not belong—indeed, it is never claimed that it belongs—to the human race; it cannot, therefore, belong to any individual. For one person to read the thoughts of another would be as much a violation or apparent violation of the laws of Nature as the demonstration of perpetual motion, the turning of iron into gold, or the rising of the sun in the west. Experiments such as here recorded, if made for the purpose of ascertaining whether certain persons have the power of reading thoughts, would be more than unnecessary; they would be exceedingly unscientific. Reasoning deductively also from the known laws of the involuntary life, the power to read muscles, in the method here described, is not only possible and probable, but inevitable. Everybody is a muscle-reader, although all are not capable of attaining the highest degrees of skill in the art.*

The one fact, the only fact brought out by these experiments that could not be predicted from known laws of physiology, is the exceeding refinement to which muscle-reading can be carried, the minuteness of the localities that are found, and the rapidity with which, oftentimes, the results are obtained. This fact is of permanent value to science, a new and positive addition to the physiology of the involuntary life, and of vast suggestion in relation to the general subject of the interactions of mind and body in health and in disease.

An incidental fact impressed on my mind during these researches was the prevalence and the power of the belief in animal magnetism. This delusion may well be regarded as the witchcraft of the nineteenth century; its hand is everywhere—on the press and the pulpit, on all our literature, on science itself, even on physiology, to which its phenomena rightly belong, and by which they can be and are fully

* Every horse that is good for anything is a muscle-reader; he reads the mind of his driver through the pressure on the bit, and by detecting tension and relaxation knows when to go ahead, when to stop, and when and which way to turn, though not a word of command is uttered.

explained. It is a tyrant that rules over the whole realm of the seemingly mysterious; the success of the orator on the platform, and of the physician at the bedside, is attributed to its aid, as of old superior learning and skill were attributed to the occult forces of magic. It may be doubted whether any other false belief of our time has had a more serious influence in retarding the progress of right reasoning than this, since it blocks the doors of investigation and prejudges the case when investigations are made, stimulates the too common habit of making the emotions do the work of the intellect, and becomes a sort of foster-mother to other and allied delusions.

It was the universality of this belief in animal magnetism that made mind-reading popular, since it furnished a basis as broad as the wildest theoriser could wish, on which could be erected a limitless variety of hypotheses; and many who rejected intuitively the claim of direct supernatural aid were made happy by the equally false and untenable claim of literal conveyance of thought from subject to operator through the agency of a supposed magnetic fluid.

ANALYSES OF BOOKS.

Illusions: a Psychological Study. By JAMES SULLY. London: C. Kegan Paul and Co.

To recognise illusions, to understand their origin, and to avoid them, is the part of the wise man, just as their unscrutinising acceptance is the task of the fool, and their propagation that of the quack and the knave. Hence the work before us should have an exceedingly wide interest. The author tells us that at bottom illusion becomes identified with fallacious inference. He says, too truthfully, that "our luminous circle of rational perception is surrounded by a misty penumbra of illusion." It must not, however, be supposed that Mr. Sully is one of those who, in language common to ultra-sceptical philosophers and to ultra-devout hymn-wrights, proclaim—

> "This world is all a fleeting show
> For man's illusion given."

Whilst declaring that we have "found a large field for illusory cognition in sense-perception, in the introspection of the mind's own feelings, in the reading of other's feelings, and finally in belief," he holds that illusion has its limits. He admits that "our intuitions of external realities, our indestructible belief in the uniformity of Nature, in the nexus of cause and effect are at least partially true,—true in relation to certain features of our common experience. At the worst they can only be called illusory as slightly misrepresenting the exact results of this experience. And so in full view of the subtleties of philosophic speculation, the man of science may still feel justified in regarding his standard of truth, a stable concensus of belief as above suspicion."

Mr. Sully classifies illusions according to their origin, obtaining four classes corresponding with four forms of cognition. Thus we have illusions of external perception, of internal perception, of memory, and of belief.

We shall turn our attention, in the first place, to the illusions of memory. The author distinguishes, as something quite apart from mere forgetfulness or from imperfect remembrance, three classes of illusions. "We may have false recollections, to which there correspond no real events of personal history; others which misrepresent the manner of happening of the events, and others

which falsify the date of the events remembered." We are in some doubt whether the date of an event should not, like its locality, and like the actors, sufferers, or other participators in the events, be simply included under the "manner of happening." However this may be, we shall find persons who will readily admit that they have forgotten the whole or a part of some occurrence, but who will yet maintain that so much of it as they do recollect must be an accurate transcript of the reality. Careful self-examination will, however, convince any of us that such is by no means the fact. As the author points out, a disputant will sometimes exclaim "I either witnessed the occurrence or else I dreamt it." A careful man may have in his memory matter which he does not like to mention, because he is not sure whether it is a portion of his personal experience, a relic of a dream, or something which he has heard or read.

Concerning one class of the spectra of memory—to wit, the dim recollections of a former life—the author makes an interesting suggestion. It is well known that the occasional occurrence of such shadowy reminiscences has been urged in favour of the doctrine of metamorphosis.* But says Mr. Sully, "May it not happen that, by the law of hereditary transmission which is now being applied to mental as well as bodily phenomena, ancestral experiences will now and then reflect themselves in our mental life, and so give rise to apparently personal recollections?" As an instance we quote the following letter, communicated to us by a friend whose name we are not at liberty to bring forward:—"In my fourteenth year," he writes, "my father judged that a knowledge of the Spanish language would be useful to me in after life. At the very first lesson the words and the sounds seemed to me strangely familiar, as if at some time I had been accustomed to hear and to use them. I had experienced nothing at all similar with the French and German languages, which I had begun to learn about a year before, and which had always seemed to me radically strange. There was nothing to account for this odd fact. No Spaniard, or person who had visited Spain, had come in my way. Being given to prying, I sought to ascertain whether my early infancy had been partly spent in Spain, but I soon got convincing evidence that I could never have been 20 miles away from the place where I was then living. I dismissed the question as beyond my reach; but about twenty years afterwards I learnt, quite accidentally, that my mother's father had passed his childhood in the neighbourhood of Malaga, and that the Spanish was his first language." This seems to us a fair instance of hereditary reminiscence.

The author observes that when old friends meet and talk over bye-gone days, there is "a gradual re-instatement of seemingly lost experiences which often partakes of a semi-voluntary process

* *See* H. G. DUVERGIER, in the Victorian Review, March 1, 1880.

of self-delusion." It seems to us that such revivals are by no means always conducive to accurate remembrance. Among a group of men who have been fellow-witnesses of, or co-participants in, events, and especially if they have been in the habit of dwelling thereon, the process of what may be called mythogenesis is very active. Instance a regimental mess, the members of a hunt, the professors of a college, &c. The joint memories of such knots of men, without any intention or consciousness of exaggeration or distortion on their part, are often full of illusions.

The memory of an event may often undergo a very rapid decomposition in the mind of a single witness, unless he reduces them to writing at an early stage. Suppose that we have witnessed some striking occurrence, not admitting in its description of any strict numerical details. Some time after it strikes us that the affair will have a particular interest for some friend. We are apt to relate it to him in imagination, and to lay a predominating weight on those phases of the matter with which he will be most struck. What we then remember will not be the occurrence itself, but our version of it, and if some time passes before we have an opportunity of telling or writing it illusions will creep in.

Mr. Sully considers that what we call recollection is uniformly a process of softening the reality. It is remarkable how little the vividness of an impression is kept up, even by the most distinct recollection of all the attendant circumstances. We may, for instance, be able to summon up every minutest detail of the death-scene of some friend, but the sorrow is only a far-off echo.

We should have been glad to notice the remaining portions of this book, and some at least of the many interesting side-issues that are raised.

The author very justly remarks:—"There seems to me no reason why an animal endowed with fine olfactory sensibility, and capable of an analytical separation of sense-elements, should not gain a rough perception of an external order much more complete than our auditory perception, which is necessarily so fragmentary."

"Spiritualist *séances*" are several times referred to in the work as hot-beds of illusion. This may be so; but we fear that the "exposers" and opponents of spiritualism might in like manner serve as an instance of equal and opposite illusions.

Electric Meteorology. An Endeavour to show the General Agency of Electricity in the Cause of Rain and its Allied Phenomena, with an Appeal for the Consideration of the Theory advanced. By G. A. Rowell. Oxford: Slatter and Rose.

This work, though small in compass, contains much matter worthy of careful consideration. The author is a heretic in science, for he considers electricity not as a modification of energy, but as a substantive entity,—in short, an "imponderable," capable of occupying space, but having a buoyant power or a minus weight. It is attracted by bodies in proportion to their temperature. The dryness of high-pressure steam and its harmlessness on coming in contact with the skin are ascribed to the particles being kept apart by coatings of electricity.

A similar explanation is given of the effects of "superheated metals," as in the experiments of Leidenfrost, Boutigny, &c. The author quotes and rejects the theories of Boutigny and Tyndall.

Fog, Mr. Rowell explains as being "composed of particles of water, each enveloped in a coating of electricity in the proportion of 860 to 1, together with atmospheric air in an inverse ratio to the density of the fog."

The cause of rain he pronounces to be vapour having lost the electricity by which it was previously supported. He believes that an upward stroke of lightning from the earth to the clouds is an impossibility. The agency of trees, especially conifers, in increasing rain and in preventing hail, seem to speak on behalf of some portion of Mr. Rowell's theory. Prof. Rolleston, in a lecture delivered May 12th, 1879, quotes certain observations of M. Becquerel on the effects of the destruction of forests as being in favour of Mr. Rowell's views.

We beg to bespeak for this little pamphlet the careful attention of meteorological observers. The only persons who can fairly criticise Mr. Rowell are those who have the opportunity of regularly studying and recording the changes of the weather. That our received meteorological notions are exceedingly imperfect is generally admitted.

The Glacial Beds of the Clyde and Forth. By T. Mellard Reade, C.E., F.G.S. Liverpool: Tinling and Co.

This memoir is a reprint from the Proceedings of the Liverpool Geological Society. The conviction has forced itself upon the author that there has been a tendency to unnecessarily complicate these Glacial phenomena,—to raise every gravel bed into a

"formation," or bed of sand into a "period," while "interglacial episodes are profusely scattered through the whole, apparently with the sole object of finding what Mr. Croll says must have happened."

Mr. Reade cannot accept the theory that the Till is wholly subaërial, and formed under land ice. It seems to him "most unphilosophical first of all to attribute the planeing, grooving, smoothing, and striating of the whole surface of the land to ice, and then to make the very same agent, without any apparent reason for the change, deposit a mass of Till in the same places, sometimes reaching 162 feet thick."

Essay on the Artificial Propagation of Anadromous Fish other than the Salmon, and the Re-stocking the Tidal Waters of our Large Rivers artificially with Smelts.

Prize Essay, National Fisheries Exhibition, Norwich, 1881, *on the Utilisation of Localities in Norfolk and Suffolk suitable for the Cultivation of Mussels and other Shell-fish.* By C. W. HARDING, Assoc. Inst. C.E. King's Lynn: Thew and Son.

THESE two essays, courteously forwarded us by the author, are valuable contributions to the good work so ably conducted by the late Frank Buckland.

We must, in the first place, enter our protest against the word "anadromous" as a piece of utterly gratuitous classicalism. Its exact English translation, "up running," would answer the same purpose, and would be more easily remembered by that large majority of the public (including multitudes of naturalists) who have either never learnt Greek, or who, like ourselves, have had to throw it overboard to make room for more important matter.

Mr. Harding announces the important conclusion that "whenever the tidal river fisheries have been more or less exhausted, the sea-fish proper, which at certain seasons of the year approach the coast, have fallen off in equal ratio." From the information to which we have access we have little doubt but that this view is correct.

The author's plea for the enactment of a close time for all fishes, and for in general preventing fishermen, in their short-sighted greediness, from killing the goose which lays the golden eggs, is just and proper. Alternate periods of glut and scarcity, in any trade, are bad for producer and consumer, and good only for monopolist middlemen. Most of all is this the case with a perishable article such as fish.

The author points to the very decided success of artificial, systematic pisciculture in America. Exhausted rivers have been re-stocked and brought back to their original state, and the public, who were at first apathetic and ignorant, have now come to take an intelligent interest in fish-preservation. Why cannot equally satisfactory results be reached here?

Among the enemies of the oyster-fisheries the author mentions the star-fish and the dog-whelk. Of the former he had last year to remove between 200 and 300 tons to prevent the bed being entirely destroyed. He has known a mussel-bed of 10 acres destroyed by these depredators in a fortnight.

The Progress of Science. Vol. I., No. 1. May, 1881. Boston: 45, Pearl Street, Boston, U.S.

We have here the first number of a new scientific organ, which, according to an editorial notice, is to be "devoted as far as practicable to original investigations; bold researches after rational truths, whether in fashion or out of fashion; well-considered speculations indicating the direction of future scientific conquests, and hints, more or less full, as to the probable means by which the intimated results may be obtained."

The articles in this first number are—An Essay on Social Science, which scarcely lies within our legitimate scope; a notice of the New Mode of Forcing Plants; a paper, singularly fallacious as it seems to us, by J. B. Dimblely, on "A Line of Astronomical Time from the Eclipses;" two articles on "Aërial Navigation," an enterprise to which we cannot wish well, believing that it will give a fearful advantage to aggressive war; "The Limits of Science," by President D. W. Fisher; "Bottled Daylight," by Eric Stuart Bruce; the commencement of a series of papers, by F. R. Condor, C.E., under the title "What the World now asks from the Inventor;" "The Perihelia," a memoir in which E. C. Carrigan ably exposes the alarmist predictions of some great calamity to happen during the current year, in consequence of the relative positions of the planets. "Godless Science" is an extract from the "New Jerusalem Magazine."

Observations on Mount Etna. By S. P. LANGLEY.

THIS memoir is a reprint from the "American Journal of Science," and treats on the atmospheric characteristices of Mount Etna as a site for an observatory. He finds that, at the altitude of the Casa del Bosco (4200 feet), stars of two-thirds the brightness of those seen in England with the like telescopic power can be distinguished. The gain on Etna, as compared with a lower station, is more in clearness of the atmosphere than in freedom from tremor. In solar work he distinguishes two classes of phenomena. In those of the photosphere, whether seen directly by the telescope or recorded by photography, an optical tranquillity of the atmosphere is of more importance than transparency. On the other hand, for spectroscopic researches and for investigations of the sun's radiant heat, transparency is essential.

During a few days' stay in Egypt the definition of the sky was almost unequalled. From his own experience, joined to that of M. Janssen in the Himalayas, he concludes that the mere fact of a high elevation by no means ensures good vision, though the chances are better at a considerable altitude, other things being equal.

Report on Insects Injurious to Sugar-Cane. By J. H. COMSTOCK. Washington: Government Printing-Office.

THE species here described are *Ligyrus ruficeps*, a lamellicorn beetle of the evil family of the cockchafers (Melolonthidæ). The insect is about ½ an inch in length, and in the larval state bores into the stem of the cane beneath the surface of the ground. If sugar-cane is deficient it destroys maize.

The "sugar-cane borer," *Diatræ sacchari*, is a moth belonging to the Pyralidæ. It also, in case of need, extends its ravages to corn. The damage done by these two species, hitherto almost overlooked, is very serious. The general public can form, as yet, not the remotest idea of the percentage of agricultural produce destroyed by insects.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

ANIMISM *versus* HYLOZOISM.

To the Editor of The Journal of Science.

SIR,—Every lover of truth and of fair play must admit that "Audi alteram partem" is a most legitimate plea, even though the views advanced under it should seem somewhat wild and extravagant, provided they are urged with some show of reason, and with due respect for the honest and cherished convictions of opponents. I have therefore no reason to complain of the author of the article which bears the high-sounding title of "Hylozoistic Materialism," whom I must suppose to be a Monist of the most pronounced type, calling in question the equally decided Dualistic views expressed in my articles on "Life and its Basis." Nor will he, I am sure, object to my testing the weight and measure of *his* arguments.

Passing by the marvellous title given to this new species of Materialism (the meaning of which even a Greek scholar would not find it very easy to understand), I must request attention to the assertion at the outset, that the views afterwards stated are "a logical deduction from the fundamental principles of Science and Theology." This last point the writer aims to prove by another assertion, viz., that the hypothesis of an Omnipresent Deity destroys "all distinction between body and soul, between God and the world." This may be C. N.'s theology, but it is not mine, nor that of the Bible. It is a simple paradox.

Observe next the *naive* confession, that while every child and every savage is an unconscious Materialist, the grandest and most mature intellects that ever adorned human science and philosophy are almost without exception arrayed *against* this theory. Moreover, I entirely demur to the correctness of the premiss, that every simple healthy human being is an unconscious Materialist. The reverse is notoriously the case, even on his own showing, or he would not have to lament over the antagonism displayed, by "learned and ignorant alike," to his theorem. I

would suggest that men's having, in the first instance, to deal with, and derive their ideas from, material things, by no means prevents their recognition of "higher entities," both in themselves and their fellow-creatures, in after life.

At p. 314 the writer specifies two of the chief antagonists to his views as being the belief in, or rather the difficulty of denying, the existence of an immaterial principle, or soul; and that matter is, in its essence, *inert*. It is plain, then, that *Hylozoism* denies, while *Animism* maintains, the existence of immaterial entities; and that while Animism considers matter, *per se*, to be inert, this Materialism endows it with essential activity. Let us take the latter thesis first. It asserts that matter is essentially active, because in a great many cases our senses do not reveal the direct cause of its motions. It appears (in the case, for example, of a falling body) to move of itself. But will C. N. contend that nothing has a real existence but that which is cognisable by our senses? Then he must give up his belief in the existence of almost every force in Nature,—*e.g.*, magnetism or electricity, for he cannot see them; indeed he cannot *see* the force in his own arm, he can only *infer* it from its visible effects; *or*, from a conscious feeling in his mind that he possesses it. For the very fact of our consciousness that we can, at will, exert force upon matter, proves that there is something in our bodies superior to matter, and therefore necessarily distinct from, however associated with, matter. But in the same page we are told, in a quotation from Dr. Lewins, that "the *anima mundi* and the *anima humana* are, at bottom, one and the same." Then the soul of man does exist after all, only it is one with the *anima mundi*. Whatever may be meant by this term, it cannot but be an entity and a unity; and the *anima* of each man must be a part of that unity. There is one trifling objection to this notion —that it is inconsistent with personal individuality; and that C. N. and myself might just as well (as far as our *animæ* are concerned) be called the same person—a point somewhat doubtful.

But further:—neither C. N. nor Dr. Lewins actually deny the existence of a Supreme Intelligence or Eternal Mind; they are good enough to allow that such a Being may possibly exist;—though we must call them Agnostics on this point. Must not, then, this Being be the *Anima mundi*? They admit, however, that there *is* something besides matter in the Universe; unless they are prepared to adopt the only logical conclusion of their speculations, viz., that God and man alike are nothing but *matter* —a position which would be an edifying illustration of the insinuation against Christian Theists in the last paragraph on p. 318, that "man creates a God after his own image."

But if there is an Infinite Mind, who can deny to it the power of giving existence to *finite* minds, call them souls or spirits, or what we will? At any rate, the admission is fatal to the doctrine

of Materialism as here stated. Nor is this all. What is the Energy, or *vis incita*, which is put forward, at p. 314 and elsewhere, as a generalisation of the Newtonian force of Gravitation, and inseparable from every particle of matter? Energy means working power, but this of necessity implies a being who *works* and exerts the power: and as the energy is everywhere, at one and the same time, the Worker must be everywhere, at all times. This energy is manifested universally, not only in Gravitation, but in Light, Heat, and perhaps other of the imponderables; for they seem to be all forms of motion in matter,—and where the work is going on, there the Worker must be. In ascribing, therefore, all these natural results to Energy, Hylozoism virtually supposes a Being acting on or *in* matter; and what is this but Dualism?

On p. 315 C. N. asserts that this inherent activity of matter renders a belief in "creative acts" superfluous and absurd, and removes the distinction between life and death (!), both of which are diverse manifestations of the same energy. Be it so; but I have shown above that this Energy is virtually a synonym for the Being whom *we* recognise as God. And this is exactly what Dualistic philosophy affirms.

But this leads me to revert to a statement made in p. 313, that "Science cannot logically assume *two* causes where one is sufficient. It is C. N.'s logic that is at fault here; for there are two manifest fallacies in this short sentence. Does he deny what is called a *chain* of causation? or the fact of one (so-called) cause depending, like a link, on an antecedent cause? In this sense Science is bound to assume two, or perhaps several causes. Again, what is meant by a cause being *sufficient*? If the cause alluded to is force or energy as an abstract notion, *independent* of a living agent, I entirely deny its sufficiency; for it has no real existence as an entity.

One word on the extraordinary assertion on p. 315, that "if we cannot deny the existence of the soul, neither can we deny that of fairies, goblins, &c., or the reality of witchcraft." This is a very rash inference; for the worst and most absurd errors are often the corruptions or exaggerations of truths. And I decline to allow that truth is reponsible for the errors engrafted upon it by popular ignorance, or attempted to be fastened on it by its opponents, whether intentionally or otherwise.

A little further on C. N. quotes my remark that plants are not possessed of moral faculties, and turns aside the force of it by allowing its truth, and then assuming that I was speaking not of the whole plant, but of the inorganic atoms of which they are built up; observing that there is nothing to show that they will ever become a sentient organism. And he proceeds to compare this with certain well-known chemical changes which produce, from the same elements, compounds of the most opposite character and properties. But who imagines that in these latter

cases there is "the entrance or exit of an *invisible entity*"? *I* do not; and if I predicate such an entity in animals* it is because they furnish evidence of volition, which cannot be reasonably ascribed to mere matter. But I must again remind C. N. that the *energy* to which he attributes chemical, as well as vital, processes, must in reason have a cause, and that a Mighty and Intelligent Cause.

There is yet another fallacy to be noticed, in p. 316. Animal life is asserted to be a mere chemical process, *because* it is maintained by several chemical operations, and "waxes or wanes" with their energy. This, however, though in reality but partially true, merely shows that vital *bodily* powers have been made, to a great extent, dependent upon these wondrous processes, and wholly fails to prove that they are identical with vitality. C. N.'s conclusion is far wider than his premisses.

In p. 317 he asserts—in opposition to my hypothesis—that cellular vitality is identical with that of the conscious brain. This may be quite true. But the brain is not the *whole* of the living organism; it is only *one* of its organs. And the fact, admitted, by no means *disposes* of the distinction he alludes to, because the *anima* is connected, more or less, with every part of the body, especially with the other vital organs, and with the blood and nerves. I beg to add that I *do* regard sensation as belonging to (not proceeding from) the nervous tissue; but perception of that sensation as belonging to the living *anima* associated with it, exclusively.

C. N. imagines a great difficulty in the way of the dualist (in the last paragraph of this page). But the difficulty vanishes in the light of the admitted fact, that the higher faculties of the soul have been made dependent (but only in our present state) upon the health and integrity of its corporeal organs, and more especially of the brain.

In conclusion, and in reply to C. N.'s protest against my assumption that the "initiation of life in non-living matter is the action of a higher power," I would ask, Is not the *energy* to which C. N. attributes it an unseen power? if we call it the *vis insita*, or "implanted force," in Nature; I ask, *Whose* force? and who implanted it? I am thoroughly convinced of the futility of the attempt to eliminate the constant, universal presence of an Almighty and All-wise Being from the material "Cosmos." Yet this is *not* Pantheism, ancient or modern; for matter is the production of God, and therefore not God himself. This Eternal, Self-existent Being is the JEHOVAH of Holy Scripture, who says

* In reference to a remark made by C. N., in p. 317, "that the consistent dualist must believe that an *anima* resides in the lowest animals," I have no doubt that this is so. But I also believe that the variety in the scale of these *animæ* is as great as that of their material organisms; and that the desired length of their individual existence is equally various, ranging from a few minutes to a virtual eternity.

of himself "I am the first, and I am the last, and beside me there is no God" (Is. xliv., 6). Being omnipresent, He can and has revealed himself to his rational creatures "at sundry times and in divers manners." And one of these manners is Nature—that wonderful Cosmos of which C. N. truly says that it is "an indivisible unity;" and this, I would add, because its Author and Sustainer is "the one living and pure God."—I am, &c.,

J. H. B.

PS.—In reference to the note at the foot of p. 317, I beg to refer the writer to the note appended to my second article in p. 81 of your February number.

BURDENSOME NEOLOGISMS.

To the Editor of the Journal of Science.

SIR,—Having heard with pleasure the enlightened views enunciated by Prof. Huxley at the opening of the Mason College, Birmingham, I was somewhat surprised to find him, in an otherwise valuable paper ("Proceedings of the Zoological Society," 1880, Part IV., p. 649), manufacturing new technical terms which must be quite unintelligible to all who are not Greek scholars. Hypicthyes, myzichthyes, chondrichthyes, herpetichthyes, hypotheria, prototheria, metatheria, and eutheria are no trifling addition to the terminology with which biological science is encumbered. It is to little purpose to found colleges in which classical studies are set aside if such studies are made imperative by reason of the Greek technical terms which are becoming from year to year more numerous and more long-winded.—I am, &c.,

COMMON SENSE.

ADVICE GRATIS IN HIGH PLACES.

To the Editor of the Journal of Science.

SIR,—Has it ever struck you as something peculiar that in this country government departments always consider themselves entitled to gratuitous scientific advice? Suppose that, for instance, some new vegetable disease has broken out in any part of Her Majesty's dominions, or some insect pest has made its

appearance, forthwith a Secretary of State writes to one of our learned societies to obtain their opinion. As a general rule a special committee is appointed to consider the evidence on the question, always voluminous and generally unscientific. Microscopic examinations have to be made, and a very considerable expenditure of time and trouble is demanded. Now were our learned societies, like those of some foreign countries, subsidised by the State, all this would be quite natural; but it is somewhat singular in case of societies which are entirely self-supported.—I am, &c.,

AMPHIOXUS.

ANIMAL CANNIBALISM.

To the Editor of the Journal of Science.

SIR,—Allow me to give your correspondent "Scrutator" a further instance of animal cannibalism. According to Jerdon's "Mammals of India" (p. 94) a wounded tiger has been observed to be dragged away and partly devoured by one of its own species. The male guinea-pig not unfrequently combines cannibalism and infanticide by preying upon his own offspring.—I am, &c.,

A. D. B.

NOTES.

THE following remarks, taken from the letter of Sir Henry Marsh on the proof "Report of the Committee of the Faculty of Medicine of the London University, have a much wider value than the writer more immediately intended, and apply to other than medical examinations, whether "final" or otherwise:—"My next proposition," he says, "should be to have annual examinations on fixed, definite, and limited subjects, and these necessary ones, and no large final, and as it now is, boundless examinations. I think this *grand* examination most pernicious in its effect on the student's mind, and ill-calculated to effect its intended object—that of being a test of proficiency. The object now before a student's mind is to be well prepared for this great and dreaded examination, and not, as it should be, to know and treat disease. The student's proficiency should also be ascertained step by step. This would be best ascertained by yearly or half-yearly examinations. Here with us this great examination, on which a young man thinks his prospects and success for life depend, is most injurious to the mind and the whole course of study. Its wide range gives a hopelessness as to being fully prepared, and the health of many has been permanently impaired. The pupils are at the mercy of the examiners, some of whom, it uniformly happens, are blockheads. Time and health are wasted in useless studies to prepare, not for practice of one's profession, but to answer either book questions or fanciful and often absurd ones. Those who are most flippant, and least disturbed by *mauvaise honte*, are, I have found in many instances, the best answerers, but the really worst informed. Grinding and cramming thrive; no one ventures on this awful examination without bringing grist to the mills of the grinders."

M. Clémandot ("Comptes Rendus") contends that the phosphorescence of bodies is due to a vibration excited chiefly by the blue ray of light.

M. E. L. Trouessart, in a communication to the Academy of Sciences, treats of the agency of marine currents in the geographical distribution of amphibious mammals. He concludes that the Otariidæ have originated in the Antarctic regions, and have branched out towards the north, occupying the shores of Patagonia, the Falklands, South Africa, New Zealand, and Australia. Humboldt's current has carried them to the west of South America as far as the Gallopagos, but no farther. Those found on the Californian coast belong to different genera, and have

arrived by the route of West Australia, the Chinese and Japanese seas, Kamtschatka, the Aleutians and Alaska, arriving finally at California from the northwards.

The Irish College of Physicians have, curiously enough, petitioned Parliament that medical practitioners should no longer be permitted to become coroners. Dr. Lyons, M.P., has refused to present it.

A so-called "Anti-Vivisection Conference" took place at Edinburgh on May 21st, under the presidence of General Grant. A paper bearing the inappropriate name of "Fact," some little time ago, expressed its satisfaction that so many naval and military officers were joining in the anti-vivisection hubbub, and stated that this conduct was the result of their "bravery." We should trace it, if true, to their ignorance of the real merits of the question—an ignorance of which "Honorary Secretaries" have not been slow to take advantage.

Prof. Calderwood, in a lecture recently delivered at Glasgow, declared that anatomical structure was not in itself a trustworthy guide in determining comparative position in the scale of organic existence, and that even comparative brain-structure could not be accepted as the sole standard of the measure of intelligence. He quoted Sir John Lubbock as declaring that, though the anthropoid apes ranked next to man in bodily structure, the ants must claim the second place in intelligence. He considered that the order of ants offered exceptional difficulties for the theory of evolution, and also for the theory of intelligence as a function of brain structure.

MM. Arloing, Cornovin, and Thomas, in consequence of the success of their experiments on inoculation for splenic fever, have applied their method on 295 cattle, and will report the result at the end of the season.

There has been found at Solana de Langostura, in the province of Segovia, the entrance to a cavern containing a number of human skeletons, mixed with flint tools and coarse pottery, some of it ornamented with very primitive designs. The perfect skulls have been sent to Madrid.

According to the "Journal of the Royal Archæological Association of Ireland," ragmen are the chief friends of the collector of antiquities.

The same journal gives an account of a genuine jade celt, discovered at Ahoghill, County Antrim. It is the only specimen of the kind hitherto discovered in Ireland, or, with the exception of one found in Cornwall, in the whole of the United Kingdom.

The same journal reprints a short tract, of the date 1679, giving an account of certain strange phenomena seen in the air at

Poins-Town, Tipperary, and seemingly belonging to the same class as the *fata morgana*.

An insecticide plant, a *Botrytis*, has been observed in the hothouses of the Botanical Garden of Montpellier. It has rapidly destroyed a number of Aphides of the genus *Siphonophora*, the remains of which are covered with the mycelium of the fungus.

We learn that the Prince of Wales, Lord Haughton, and Dean Liddell have been elected Trustees of the British Museum. We think that, *e.g.*, Lord Walsingham would have been much more suitable than either of the two latter.

According to the "Echo"—"At length a small modicum of authentic information has leaked out as to the doings of the Committee on Solar Physics at South Kensington. From consecutive statements made at the meeting of the Royal Astronomical Society by Mr. Lockyer and Mr. W. H. Christie, on the evening of the 13th ult., it would appear that this secretly-appointed company has been engaged in making observations which for some time past have been as well, or better, made at the Royal Observatory at Greenwich!"

Two new eyeless snails have been discovered in the underground waters of Carriola.

The funeral of M. Littré, the "positivist" leader, gave rise to a decided tumult."

The "Inventor's Record" states that "a spiritualist is going to bring out a book called 'The Occult World,' based on his experience in the East." The work in question contains the express declaration that "occult phenomena must not be confounded with the phenomena of Spiritualism," and the author even states "It is not my present task to make war on Spiritualism."

Sir John Lubbock finds that ants are sensitive to the ultra-violet rays, and carefully carry away their larvæ from under its influence. (We have long ago been led to the opinion that insects enjoy a different, and probably wider, range of vision than do vertebrate animals.

A popular journal gives the following alarming prescription for the treatment of gnat-bites:—"Alcohol, 1 part; crystallised carbolic acid, 9 parts!"

A "Field Club," with botanical, geological, and entomological sections, has been organised at Buffalo.

According to special investigations, conducted at the Smithsonian Institution, the green colour observed in certain oysters is due not to the presence of copper, but to certain green Algæ upon which the oyster feeds eagerly.

M. Pasteur has shown that the seat of the poison of rabies is not in the saliva alone; it is present in the brain, and with at least equal virulence.

"Mr. Cumberland" is about to publish a book explaining the methods used by mediums to produce spiritual manifestations.

M. A. Béchamp, in reply to a recent paper by M. Pasteur in the "Comptes Rendus," maintains the existence of *Microzyma cretæ*, by the action of which he has obtained alcohol, acetic, lactic, and butyric acids.

M. Richet has laid before the Academy of Sciences a paper on the movements of the frog consecutive on electric excitation.

Dr. Ayres ("New York Medical Journal") thinks it idle to look for a picture of the surroundings on the retina of a person who has met with a violent death.

According to the "Chemiker Zeitung" Profs. Kolbe and E. von Meyer have detected two spurious inaugural dissertations put forward by A. O. Lütkemeyer and A. Weinberg. Both are simply copies of pre-existing documents.

Since 1864 Mauritius has been stripped of its forests, and its fertility and salubrity have alike suffered. The hills are now being re-planted.

"La Nature" wisely cautions naturalists to complete the study of the larger Mammalia, birds, and reptiles, before their certain extirpation.

We learn from the "Popular Science Monthly" that the students of Harvard University have been formally canvassed as to their religious opinions! This reminds us of a certain "declaration" that was got up some years ago, and sent round for signature among the Fellows of our learned societies.

Dr. Hureau de Villeneuve has come forward as the President of the Vegetarian Society of Paris. Like many of his fellow "dietetic reformers" in England, he tolerates the use of eggs, milk, butter, and cheese, which certain American enthusiasts reject as "putrid curd."

We regret to learn that Mr. Shelford Bidwell's paper on "Telegraphic Photography," to have been read before the Society of Arts on May 26th, has been postponed owing to the severe indisposition of the author.

The British Association has not yet summoned up the courage necessary for the amputation of its "economic section"—a much-needed operation.

M. G. de Saporta, in a communication to the Academy of Sciences, expresses doubts as to the supposed occurrence of the Proteaceæ in the European fossil flora.

According to M. A. Gaudry the Permian reptiles of France diminish the vast interval which exists at present between the reptiles and the monotrematous mammals.

The ferment which M. Béchamp supposed he had discovered in chalk has been traced, by MM. Chamberland and Roux, to an experimental error.

According to M. Tayon the production of wool in sheep is inversely as the secretion of milk.

The "Chemiker Zeitung" states that all the English and French professors at the University of Yeddo, Japan, have been dismissed, and their places filled with Germans. The Japanese Minister of Public Instruction is a German professor. The Chinese are about establishing a German University at Pekin. These facts should be duly weighed by those who still doubt the superiority of German research over English cram and examinations!

J. Starkie Gardner ("Geological Magazine") re-discusses the question of the permanence of continents and sea-depths. He considers that though the greatest depths of the ocean may have always been permanent, the banks and ridges, with islands occasionally rising to the surface and crossing the Atlantic or Pacific, must be either rising or sinking.

Mr. C. S. Wilkinson, New South Wales Government Geologist, has discovered glacial boulders in secondary deposits, near Sidney.

The working naturalists of Des Moines have organised a so-called "Agassiz Field Club."

The larvæ of certain Bombyliidæ—so-called bee-flies—prey eagerly on the eggs of the dreaded American locust, *Caloptenus spretus*.

Lord Walsingham enumerates forty-eight species of Tortricidæ common to Europe and the Pacific coast of North America.

A reprint of the compendium of the natural sciences, written in the ninth century by Rhaban Maurus, and used for a long time as a text-book at the College of Fulda, has recently appeared. It includes astronomy, geography, anthropology, and theoretic medicine, and in all these departments it ignores all facts not to be found in the writers of classical antiquity.

Dr. Hermann Mueller deals a crushing reply to Bonnier's supposed refutation of the inter-relation of flowers and insects.

There are suspicions that the *Phylloxera* has found its way to the vineyards of Victoria.

The larva of a Coleopterous insect, supposed to be that of a *Lytta*, is found to destroy the eggs of the locust in the Troad.

It is known to most of our readers that a medal has recently been struck in honour of M. Milne-Edwards, the opponent of Evolutionism. The "Revue des Sciences Biologiques" gives a very clever article called "The Reverse of the Medal," which may be profitably read by the friends of "official science" on this side the Channel. The sterile and retrograde condition of French biology is due to his influence, which has been exerted with an omnipotence which no *savant* ever before possessed in any country. He has imprisoned zoology in the narrow ideas of Cuvier; he has energetically and patiently combatted all progress, repressed merit, and sought by all means to isolate the youth of France from the great scientific movement going on in neighbouring nations.

M. Pauchon has made a series of experiments with beans, on the influence of the colour of seeds on germination. He finds, in order to reach the same visible stage of development, a black or violet seed absorbs more oxygen than a white or yellow one, though a more rapid germination is observed in the latter. On the other hand, the quantities of carbonic acid exhaled by white seeds are found to be greater than those from the dark, sometimes even double. These differences are considered to prove that dark or violet seeds are better conditioned from a physiological point of view. In the natural state, *i.e.*, when the seeds germinate in light, the conversion of legumin into asparagin must go on much more easily in the coloured seeds than in the others. "The more frequent and pronounced pigmentation of seeds of northern lands is, therefore," says M. Pauchon, "a favourable circumstance for the growth of these organisms, under the peculiar light conditions to which they are subject."

Lord Walsingham, in a paper read before the Entomological Society, gave several instances of Micro-Lepidoptera found in South Africa, and identical with, or at least closely allied to, forms supposed peculiar to South America.

The question as to whether the larvæ of moths ever breed in the horns and hoofs of living animals is still undecided.

According to H. von Koppenfels ("American Naturalist") mongrels between the male gorilla (*Troglodytes gorilla*) and the female chimpanzee (*T. niger*) occasionally occur in the Gaboon district. Du Chaillu's Kooloo-Kamba, N'schigo, M'bouve, &c., are only names given to the chimpanzee by different tribes.

The *Cervus maral*, of Western Siberia, exists in a state of domestication among the Cossacks near Kiakhta.

Dr. S. V. Clevenger ("Science," May 28) supports, in opposition to Prov. Mivart, the view of Mr. H. Spencer, that instinct is a higher development of reason.

Mr. A. H. Swinton, who is favourably known to many of our readers from his work on "Insect Variety," writes as follows to "Science":—"It may concern some of your readers to know that I have just made the interesting discovery that the multiplication and migration of the rocky mountain locust [*Caloptenus spretus*] has been hitherto in exact agreement with the minima of Wolf's sun-spot cycles as given in the "Mem. Astr. Soc." (vols. xlii. and xliii.), and its decrease has as nearly accorded with the maxima, there not being a year's difference. On European areas insect migration but rarely agrees with these maxima and minima, the chief periods being obtained by counting the elevens since 1846. It would be important to determine the multiplication of corn-weevils in relation to the sun-spots. Cannot the trade keep diaries? As the more destructive kind comes from the tropics, the minimum period should be dreaded."

Lasaulx ("Mineralog. Mittheil." n. s., vol. iii., p. 517), after a careful examination, pronounces the inorganic portion of the atmospheric dust to be of purely terrestrial, and not cosmic, origin.

According to Dr. C. Meineret the proportion of nitrogen excreted without assimilation is, in meat and eggs, 2·6 per cent; in milk, 7; in maccaroni, 17·1; in peas, 27·8; in lentils, 40·2; in white wheat bread, 19·9; and in brown bread, 42·3 per cent. Hence it appears that a much larger proportion of the nutriment is utilised in case of animal than of vegetable food. How do the vegetarians propose to deal with this consideration?

It has been decided in Paris that there can be no binding agreement between a patient and his doctor, the former not being regarded as a free agent.

It is considered probable that Palenque was already deserted and in ruins at the time of the Spanish conquest of Mexico.

Mr. F. A. Ober, after a careful examination of the ornithology of the Carribbee Islands, finds that each group has one or more species peculiar to itself. He has discovered about twenty birds new to Science.

We are glad to learn, from communications received, that the new Technological and Industrial Museum at Sydney will include a department of economic entomology, the specimens being so arranged as to enable the public to discriminate between insects injurious to man and such as work for his benefit. The insects will be shown in all stages of growth, and along with them specimens of the materials spoiled or injured. Where actual specimens cannot be exhibited, the career of the insects will be illustrated by models and diagrams.

"The Lancet" on Competitive Examination.—The competitive system, as applied to youths, has produced a most ruinous effect on the mental constitution which this generation has to hand down to the next, and particularly the next-but-one ensuing. Schoolwork should be purely and exclusively directed to development. "Cramming" the young for examination purposes is like compelling an infant in arms to sit up before the muscles of its back are strong enough to support it in the upright position, or to sustain the weight of its body on its legs by standing, while as yet the limbs are unable to bear the burden imposed on them. Another blunder is committed when one of the organs of the body—to wit, the brain—is worked at the expense of other parts of the organism, in face of the fact that the measure of general health is proportioned to the integrity of development and the functional activity of the body as a whole in the harmony of its component systems. No one organ can be developed at the expense of the rest without a corresponding weakening of the whole. These faults of "training" attain their supreme height of folly and shortsightedness when they are committed in reference to the youths destined for the public services. The work of the Civil Service Commissioners in respect of these classes is individually and racially destructive. Sooner or later public opinion must recognise this fact, and then perhaps the Legislature may be moved to intervene—not before, but when it is too late. (In fact, for the sake of securing one moderately efficient young man for the public service, some five or six, including the successful candidate, are injured for life! It is impossible to avoid invoking a solemn curse on the originator of this scheme.)

Prof. E. Ray Lankester on Competitive Examination.—We are mistaken—indeed very seriously mistaken—in supposing that competition for places can do much to raise the standard of scientific work. Good patient work, due to the free workings of genius, and that unconscious aptitude and insight which belong to it, is not fostered, but actually forbidden,—starved at the roots by the wear and tear of competition.

ERRATA.

Page 364, line 13 from bottom, *for* "all volcanoes are on the top of mountains" *read* "nearly all," &c.

Page 363, line 6 from bottom, *for* "48·250" *read* "48250."